

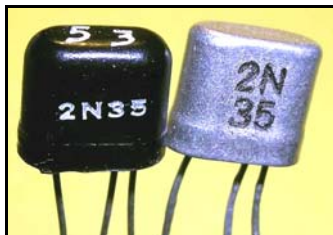
TRANSISTOR MUSEUM™

# HISTORY OF TRANSISTORS

**VOLUME 1**  
**THE FIRST GERMANIUM HOBBYIST TRANSISTORS**

Special Collection of Historic Transistors  
Designed for the Historian, Engineer,  
Experimenter, Researcher and Hobbyist

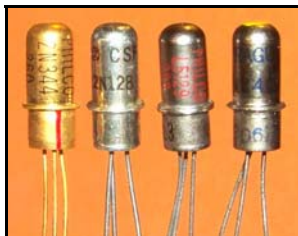
**INCLUDED ARE CLASSIC EXAMPLES OF THESE  
1950/60s GERMANIUM HOBBYIST TRANSISTORS**



2N35



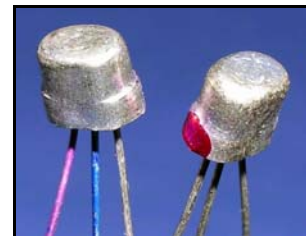
2N107



SURFACE BARRIER



2N170



CK78X

A Publication of the Transistor Museum™

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# ABOUT THIS BOOK AND THE TRANSISTOR MUSEUM™

This book is the first of a series of History of Transistors publications developed by the Transistor Museum™. The History of Transistors Volume 1 documents **The First Germanium Hobbyist Transistors**, a subject that should be of great interest to the modern-day experimenter, engineer, historian, researcher and hobbyist. Included in the book are technical descriptions, historical commentary, circuits, and photographs of the famous germanium transistors that first appeared in the 1950s and have had a profound effect on the world of electronics ever since. Also included are working examples of some of the best remembered hobbyist transistors - **2N35**, **2N107**, **Surface Barrier**, **2N170**, and **CK78X**.

The web version of this book is available as a pdf at this url:

<http://www.semiconductormuseum.com/MuseumLibrary/HistoryOfTransistorsVolume1.pdf>

You can purchase a hardcopy version of the book, which also includes packaged examples of all five hobbyist transistors listed above, as well as additional storage/display envelopes for starting your own collection. You can visit the Transistor Museum™ Store for details on how to purchase this book as well as numerous other historic semiconductors and publications.

[http://www.semiconductormuseum.com/MuseumStore/MuseumStore\\_Index.htm](http://www.semiconductormuseum.com/MuseumStore/MuseumStore_Index.htm)

The Transistor Museum™ is a virtual museum that has been developed to help preserve the history of the greatest invention of the 20<sup>TH</sup> century - the TRANSISTOR. You can visit the museum on the web at:

<http://www.transistormuseum.com>

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THE FIRST GERMANIUM HOBBYIST TRANSISTORS

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

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INSERT SHEET WITH YOUR FIVE CLASSIC HOBBYIST TRANSISTORS

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# **HISTORY OF TRANSISTORS VOLUME 1**

## **The First Germanium Hobbyist Transistors**

### **A BRIEF HISTORY OF TRANSISTORS**

The transistor was invented by John Bardeen, Walter Brattain and William Shockley at Bell Labs in December, 1947. Announced to the public in June, 1948, this new device had characteristics which could be used to overcome many of the fundamental limitations of vacuum tubes - transistors had very long life, were small, lightweight and mechanically rugged, and required no filament current. The commercial use of transistors increased dramatically in the 1950's, beginning with telephone switching equipment and military computers in 1952, hearing aids in 1953, and portable radios in 1954. In 1953, over 1,000,000 transistors were manufactured; in 1955, 3,500,000 transistors were manufactured, and by 1957, annual production had increased to 29,000,000 units. The rapid rise of transistor technology in the 1950s can be attributed to the contributions of a few major companies, including Bell Labs/Western Electric, Fairchild, General Electric, Motorola, Philco, Raytheon, RCA, Sylvania and Texas Instruments.

The first types of transistors available in the 1950s were made from germanium - this is an element known as a semiconductor, which is a category of material that is neither fully conducting nor fully insulating when an electrical voltage is applied. Semiconductors are ideally suited for the construction of amplifying crystals, as the earliest transistors were sometimes described. Another semiconductor element, silicon, was the basis for extensive research in the early 1950s because it was recognized that transistors fabricated from silicon would have superior performance at higher operating temperatures. By 1954, commercial silicon transistors were available from Texas Instruments and the basic concepts used in the development of these devices have been continuously improved over the decades and have lead directly to the development of today's integrated circuit and microprocessor devices.

During these first two decades of transistor history, a variety of different device types were developed and this diversity of technologies has lead to a rich historical backdrop of early transistor shapes, sizes, specifications and circuits. The next few pages will provide more information regarding early transistors. We'll discuss in some detail the technology of these first transistors; this should provide the reader with an excellent understanding of the circumstances that lead to the development of hobbyist transistors in the 1950s and 1960s.

# **HISTORY OF TRANSISTORS VOLUME 1**

## **The First Germanium Hobbyist Transistors**

### **LEARNING ABOUT EARLY TRANSISTOR TECHNOLOGY**

The following six sections present an overview of some important technological aspects of early transistor construction and use.

#### **1. Semiconductor Material**

The first transistors were fabricated from germanium. In the late 1940s, there was an established germanium diode business, created initially by Sylvania in 1946 with the well known 1N34 device. Silicon diodes had been developed during World War II for use as radar mixers, so there was industry experience with both germanium and silicon. The research at Bell Labs that led to the invention of the transistor in 1947 had been conducted using germanium, and this work provided the basis for the initial commercial production of transistors. By the mid 1950s, TI had developed the first commercial silicon transistors, but this technology was limited to a few expensive devices. Germanium technology was dominant into the mid 1960s, but was eventually superseded by silicon when manufacturing advances pioneered at TI, Fairchild and others led to inexpensive, high performance silicon transistors. Germanium transistors were used extensively by hobbyists in the 1950s and 1960s, with silicon hobbyist devices appearing in the late 1960s.

#### **2. Manufacturing Technology**

In the 1950s, extensive transistor research led to a variety of unique (and now obsolete) device types and manufacturing technologies; there were frequent breakthroughs as new types were developed and introduced commercially. The first transistor technology was known as point contact device, and this technology was soon superseded by higher performance types such as grown junction, alloy junction and surface barrier. These latter three types became the dominant technology in the 1950s and were used extensively by hobbyists. Each of these types will be discussed in greater detail in a later section.

# **HISTORY OF TRANSISTORS VOLUME 1**

## **The First Germanium Hobbyist Transistors**

### **LEARNING ABOUT EARLY TRANSISTOR TECHNOLOGY**

#### **3. Case Material**

There was experimentation with transistor case shape and material during the 1950s. The first point contact transistors to enter production, the Bell Labs "Type A" were metal cartridge devices. The first experimental junction transistor, the Bell Labs M1752, used a plastic epoxy case. Until the mid 1950s, both plastic and metal cases were used in the development of transistors, but the use of plastic became less common when it was determined that the performance of plastic case devices would degrade over time, due to moisture penetration of the case and resultant degradation of the germanium junctions. In the early 1960s, Motorola and General Electric successfully introduced plastic cases that were designed to be robust and inexpensive, and the 1960s saw widespread industry use of both plastic and metal. Hobbyists may remember the black plastic Raytheon CK722 from the early 1950s, but most other hobbyist devices until the late 1960s were metal.

#### **4. Electrical Polarity**

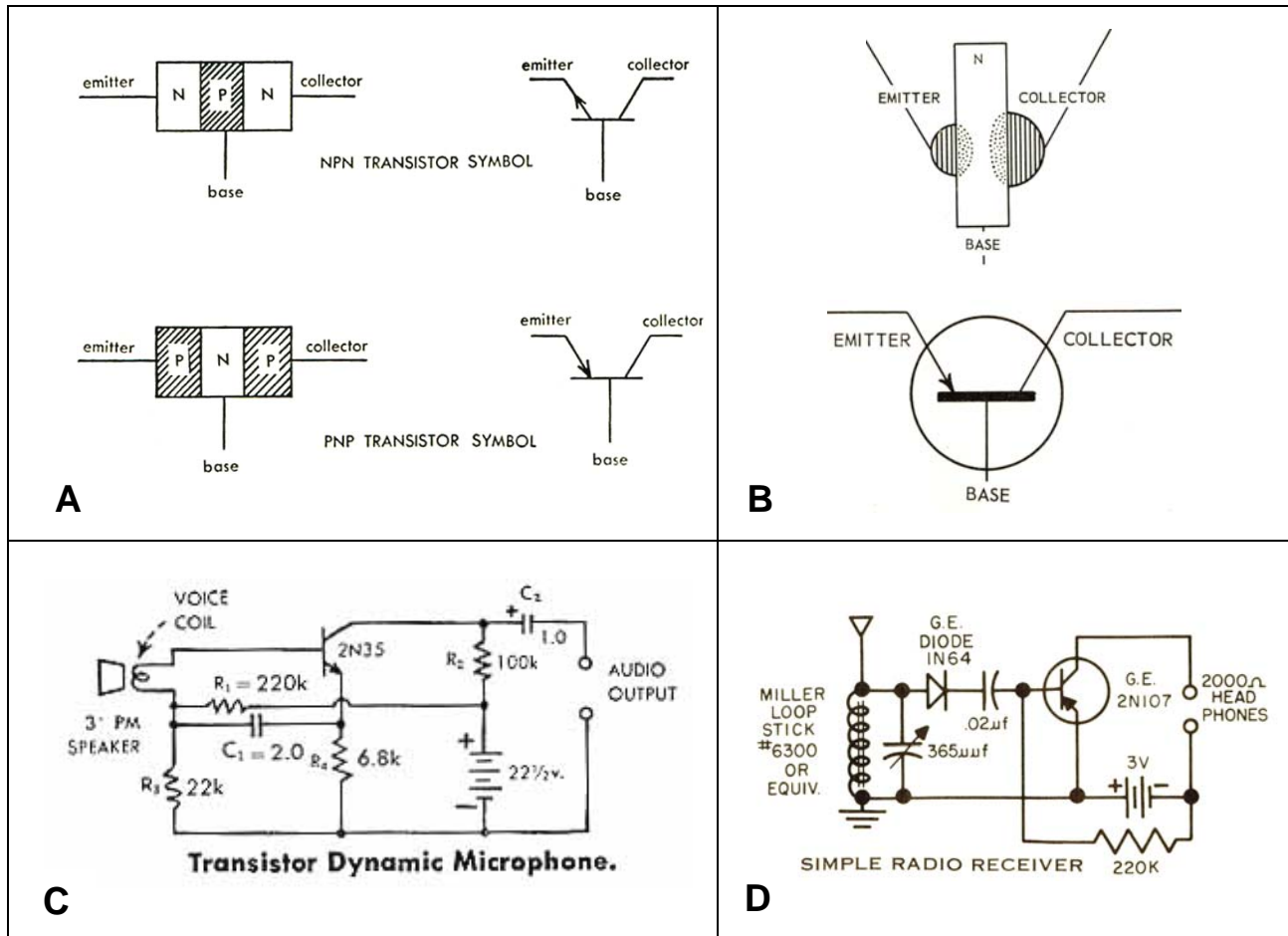
Early transistors were produced using semiconductor material that had been processed during manufacturing with the addition of small amounts of chemical impurities, such as arsenic or antimony. This process was known as "doping", and was required in order to create the proper crystalline structure in the semiconductor to allow transistor action. Depending on the specific doping elements used, the resultant transistors would be categorized as either PNP or NPN, which is a representation of the electrical polarity to be used with the transistor. For example, a PNP (Positive - Negative - Positive) transistor would require a specific set of Positive and Negative voltage polarities to be used for the three transistor terminals in circuit applications; an NPN transistor would require all circuit voltage polarities to be reversed from those defined for a PNP. Many circuit applications require the use of both PNP and NPN transistors, and hobbyists should be familiar with both types.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### LEARNING ABOUT EARLY TRANSISTOR TECHNOLOGY

#### 5. Early Transistor Circuit Symbols and Diagrams



Figures A and B above illustrate typical diagrams and symbols that were used in the mid 1950s to identify the two most common types of junction transistors (NPN and PNP). Figures C and D illustrate the most common style of transistor symbols, as used in circuit schematics of the time. Note that the direction of the "arrow" of the emitter terminal is the primary indication of PNP (arrow points to the base) and NPN (arrow points away from the base). The use of an enclosing circle around the transistor symbol was used optionally, for both PNP and NPN types. (Figures A and C are from reference [9], Figure B is from [6] and Figure D is from [7]).



# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### LEARNING ABOUT EARLY TRANSISTOR TECHNOLOGY

#### 6. Performance Category

Early transistor types represented the first stages of development for this new technology, and the first devices were quite limited in performance capabilities. Such operational characteristics as noise level, gain, operating frequency and power handling capability were all at low levels of performance for the first few years of transistor development, although tremendous progress was made throughout the 1950s and 1960s. Most early transistor types were identified by the manufacturer according to specific performance characteristics. For example, most PNP germanium alloy types had limited frequency performance and were marketed for use as audio amplifiers. NPN germanium alloy and grown junction types had better high frequency characteristics and could be used in RF/IF radio circuits or in computer switching applications. Hobbyist types usually were identified in a similar manner, with a range of intended applications which included audio amplifier, low noise audio preamplifier, RF/IF amplifier, and audio power amplifier. As transistor technology improved, hobbyist types were sometimes identified as "General Purpose", and could be used in a variety of hobbyist circuits.

#### 7. Summary

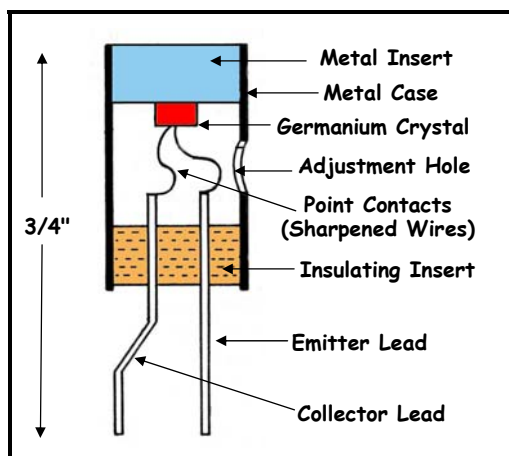
A memorable event from the early days of transistor history was the introduction in the 1950s of the first germanium hobbyist transistors; countless thousands of experimenters and young engineers still remember their first "hands-on" experience with this seemingly mystical technology when that long-awaited mail package arrived from Radio Shack, Lafayette or Allied Radio and revealed the brightly packaged germanium hobbyist transistors. Whether the intended project was a one-transistor radio, a code practice oscillator, a Geiger counter or a high gain audio amplifier, the universal appeal of these early hobby transistors is undeniable - this History of Transistors publication, "The First Germanium Hobbyist Transistors" has been written to provide a comprehensive survey of this important (and well-remembered) milestone in semiconductor history.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### TYPES OF EARLY TRANSISTORS - POINT CONTACT

The first transistors utilized a technology known as point contact, which was a technique similar to that used to manufacture silicon radar mixer diodes during WWII. In a point contact transistor, two tiny sharpened wires are pressed against a small block of germanium; in this configuration, current flow between the two wires can be controlled by current flow introduced into the germanium block. Point contact transistors never achieved large volume production or commercial usage, mostly because the manufacturing process was quite unpredictable, with final device performance depending on such parameters as the physical placement of the two wires to within .001 of an inch. The earliest point contact units had a small hole in the case to allow for adjustment of the wire placement and downward pressure to achieve desired performance. Another negative aspect of the early point contact transistor performance was excessive noise - these devices were very noisy and weren't suitable for most amplifier type applications, whether in a radio or a hearing aid. Point contact transistors did find limited usage as switches, in such equipment as telephone switches and digital computers. Several companies entered the transistor manufacturing business initially with point contact units, but because of the inherent limitations of this type of device, production volumes were low. This technology was soon superseded by a new type of transistor, called the junction transistor. After 1954, there was almost no point contact transistor manufacturing, although Western Electric continued to produce the 2N110, a point contact switching unit, until the 1960's. Due to the scarcity of these early devices, and poor performance, point contact transistors saw very limited usage in hobbyist projects.



Adapted from [1]

#### Cartridge Type Point Contact Transistor

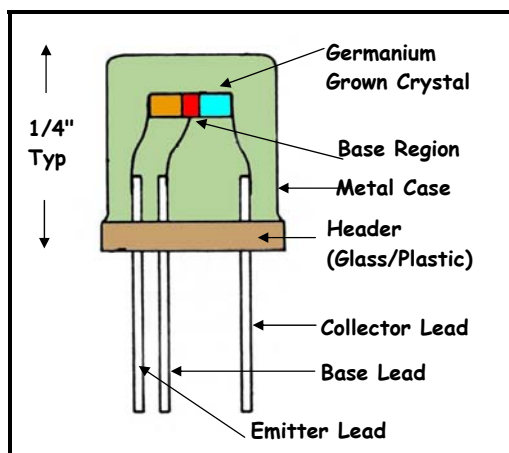
Shown at left is a block diagram of one of the first types of point contact transistor - this cartridge type was first developed at Bell Labs in the late 1940s. A metal cartridge-style shell was used as the case for these early devices, which required very complex mechanical assembly and adjustment processes. Yields were low and there was little uniformity. Best performance was obtained when the two metal wire point contacts were physically adjusted through a hole in the side of the case. Other case styles, including plastic epoxy, were also used for early point contact

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### TYPES OF EARLY TRANSISTORS - GROWN JUNCTION

Junction transistor theory was developed by William Shockley at Bell Labs in 1949, shortly after the point contact transistor had been patented and low volume manufacturing of point contact units had begun. The first junction transistor was created at Bell Labs in 1950 [3], using a technique known as grown junction. In this process, a crystal of high purity germanium was grown in a furnace and during the growth process, an impurity was added to the "melt" which introduced a thin base region into the final crystal. By 1952, production quality junction units were being manufactured in small numbers by Bell Labs. Junction transistors overcame many of the limitations of point contact transistors. For instance, junction units were able to operate quite well as amplifiers, because inherent noise levels were low and frequency performance was well matched for audio use. Equally important, the manufacturing processes for junction transistors could be made much more controllable than the "hand-adjusted" approach needed for point contact units. With overall better performance and with more manageable manufacturing processes, the junction transistor technology set the stage for the obsolescence of the original point contact type. Germanium grown junction transistors were sold in large numbers commercially throughout the 1950s, and found widespread use in such consumer applications as hearing aids and radios. Western Electric, Texas Instruments and General Electric were the primary manufacturers of this transistor type. Examples of germanium grown junction transistors from these companies include (WECO 2N27), (TI 2N172) and (GE 2N170).



Adapted from [1]

#### Grown Junction Transistor

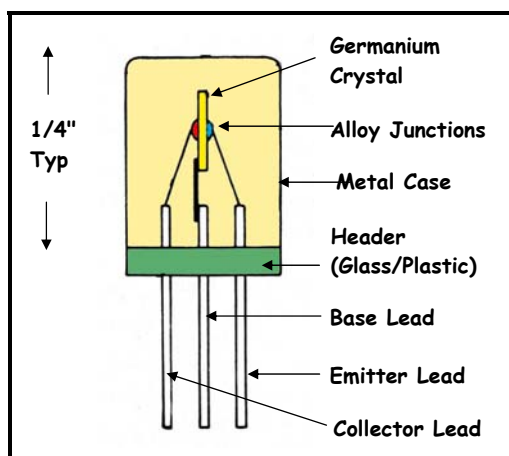
Shown at left is a block diagram of the first style of grown junction transistor. The small germanium crystal was usually N-type, with a P-type impurity added for the base junction region; this results in an NPN transistor, which represents the primary form of this device type. The initial manufacturing processes were difficult to control (variable thickness of the impurity layer), and performance of the early devices was poor at high frequencies. GE developed an improved process, known as rate-grown, which overcame many of the early device limitations.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### TYPES OF EARLY TRANSISTORS - ALLOY JUNCTION

Although grown junction transistor technology offered considerable advantages over the original point contact type, there was substantial research in the industry to further improve the state of the art. Within two years after the development of the grown junction transistor at Bell Labs in 1950, two other companies (GE and RCA) were producing experimental devices, known as alloy junction transistors, which would provide the basis for most germanium transistor manufacturing throughout the 1950s. In an alloy junction transistor, two small "dots" of an appropriately prepared elemental material (usually indium for a PNP device) are alloyed, or melted, onto each side of a thin germanium crystal. This process, done under precisely controlled temperature, causes a small amount of alloyed material to diffuse into the germanium crystal, resulting in a transistor structure. The design and manufacturing aspects of the alloy junction transistor were found to be suitable for high volume production of units with pre-defined performance characteristics. The early junction transistors of each type, grown and alloy, had similar operational characteristics, but there were rapid advances in alloy junction technology, especially in high frequency performance and device uniformity. Most major semiconductor companies entered high volume production with the alloy junction process, including Raytheon, RCA, General Electric, Sylvania, and Texas Instruments. This transistor type, with several improvements, dominated the field until the late 1950s. Transistorized consumer products from this era, including Japanese radios, primarily used alloy junction devices. Examples of germanium alloy junction transistors include (GE 2N107), (RAY CK722), (RCA 2N109) and (SYL 2N35).



Adapted from [1]

#### Alloy Junction Transistor

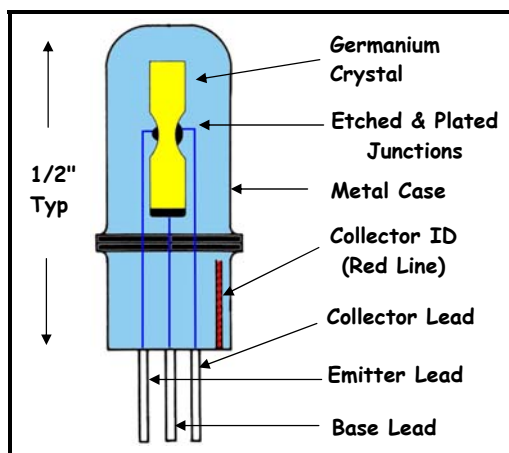
Shown at left is a block diagram of a typical alloy junction transistor, as developed in the 1950s. The transistor junctions were formed by alloying two small pellets onto either side of the germanium crystal. The collector pellet or "dot" was usually larger than the emitter, in order to accommodate higher power output. Both PNP and NPN transistors could be made using this process, although PNP was more common. The alloy manufacturing process continued to be used into the 1960s, and became the most widespread germanium transistor technology.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### TYPES OF EARLY TRANSISTORS - SURFACE BARRIER

The surface barrier transistor (SBT) was developed at Philco in the early 1950s. Although somewhat similar in concept to a junction device, the actual manufacturing process was quite different and the operational characteristics of the SBT were unlike grown and alloy junction transistors. In the original manufacturing process of the SBT, a jet of electrically charged etchant was directed onto each side of the germanium die, and the length of time that the etchant was applied would determine the resultant thickness of the germanium junction area. No alloying was used to create the emitter and collector regions of the transistor - instead, electroplating was done, using a reverse polarity to the etchant spray, to plate the collector and emitter regions onto the germanium die. The etchant process could be controlled very precisely, which meant that the base region of the transistor could be made very thin (early SBTs had a .0002 inch base region). This unique manufacturing process produced transistors which would function at much higher operating frequencies than the other transistor types of the day. SBT transistors found widespread use in a variety of applications that required excellent high frequency performance, such as computer switching circuits and radio receivers/transmitters. Philco continued to improve the SBT technology throughout the 1950s and 1960s, including the transition to silicon SBT-related types in the 1960s. Although not specifically designed for hobbyist use, the unique high frequency characteristics of SBTs resulted in quite a bit of hobbyist experimentation and circuit development. SBT devices were obsolete by the 1970s, except as replacement and repair use for earlier applications.



Surface Barrier Transistor

Shown at left is a block diagram for the SBT transistor type. Note the relatively thin base region of the germanium crystal, located between the collector and emitter junctions. The electro-mechanical etching process used to manufacture the SBT could be precisely controlled to produce a very thin base region, resulting in devices with excellent high frequency performance. Philco invented the SBT type and was the prime supplier - Sprague became a major second source supplier in the late 1950s. SBTs found widespread use in digital computers and radios.

**HISTORY OF TRANSISTORS VOLUME 1  
The First Germanium Hobbyist Transistors****LEARNING ABOUT GERMANIUM HOBBYIST TRANSISTORS**

When transistors first became available in the 1950s, there was already a well established electronics hobbyist market, created primarily by the leading vacuum tube manufacturers of the time. These companies enthusiastically marketed to experimenters, educators, and "ham" radio operators. This activity was continued with transistors, and was successful for several reasons: (1) Early transistor manufacturing processes were very inefficient, with low yields and resultant large quantities of "out of spec" transistors which were ideal for the hobbyist market, (2) There was a large demand by hobbyists for the "new" transistor technology, and commercial devices were too expensive for experimenters, and (3) Many of the first transistor manufacturing companies also had established "Applications/Publications" groups that were responsible for developing new hobbyist projects and booklets. All these factors lead to a large and successful transistor hobbyist market for many years. Shown below are the companies that were instrumental in developing the hobbyist transistor market - these companies, and their famous hobby-style transistors and publications, are all well remembered by electronics hobbyists, experimenters and young engineers from the past 50 years.

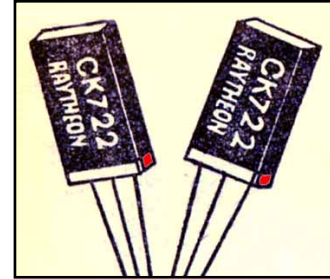
<b>HOBBYIST TRANSISTOR COMPANY</b>	<b>TIMEFRAME</b>	<b>BEST KNOWN HOBBYIST TRANSISTORS</b>
<b>RAYTHEON</b>	<b>1950s-1960s</b>	<b>CK721, CK722</b>
<b>GENERAL ELECTRIC</b>	<b>1950s-1970s</b>	<b>2N107, 2N170</b>
<b>RCA</b>	<b>1950s-1970s</b>	<b>2N109</b>
<b>SYLVANIA</b>	<b>1950s-1980s</b>	<b>2N35, 2N229</b>
<b>PHILCO</b>	<b>1950s-1960s</b>	<b>SB100/SBT</b>
<b>MOTOROLA</b>	<b>1960s-1980s</b>	<b>HEP Series</b>
<b>RADIO SHACK</b>	<b>1950s-2000s</b>	<b>"Bargain-Packs"</b>

# HISTORY OF TRANSISTORS VOLUME 1

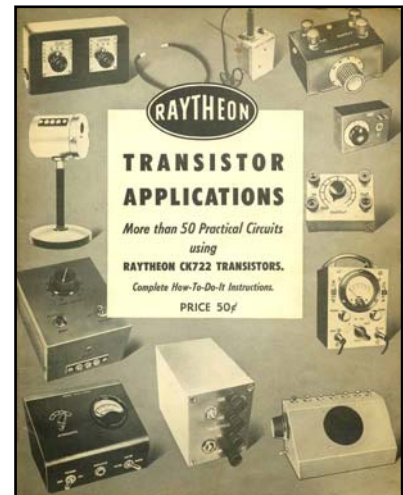
## The First Germanium Hobbyist Transistors

### RAYTHEON (1950s - 1960s)

Beginning in 1953, Raytheon was the first company to actively pursue the transistor hobbyist market. There were several unique factors which supported this approach; (1) Raytheon already had an established presence in the hobbyist/radio amateur market for vacuum tubes, (2) Raytheon had implemented large scale production of germanium alloy junction transistors in 1952 to support the transition of the hearing aid business from submini tubes to transistors and (3) the production yield of these early transistors was low, which meant that there were thousands of Raytheon transistors which didn't meet the exacting performance standards required for hearing aid use, but which were well suited for the hobbyist market. In early 1953, Raytheon began supplying the substandard hearing aid transistors, now relabeled "CK722", to the editors of various electronics industry publications of the time in an effort to "jump start" the demand for these devices for hobbyists. This was a very successful strategy, with dozens of articles appearing in the next few years utilizing the CK722. Continuing to build on this momentum, Raytheon published a low cost compilation of these articles on CK722 applications, further enhancing the demand for these transistors. A second volume of germanium transistor applications was published by Raytheon in 1957. The CK722, and the higher performing CK721, were very successful products, with 100,000s of units sold in the 1950s and 1960s. Many of today's engineers still remember their first experience with transistor technology when they bought their very own Raytheon CK722. Raytheon continued to market hobbyist and replacement germanium transistors into the 1960s.



This is an illustration of the classic CK722, introduced by Raytheon in 1953. These first versions had a black epoxy case - later versions were metal cased, painted blue in the mid 1950s and plain silver for later versions.



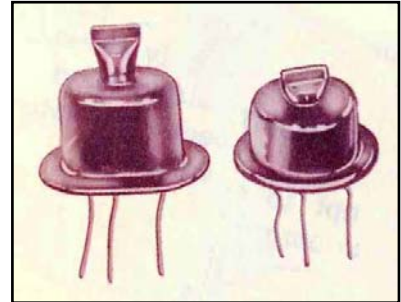
This is the cover of the 1955 Raytheon publication that was a compilation of many of the CK722 articles that had previously appeared in hobbyist magazines. This booklet was very popular with hobbyists and further enhanced the success of the CK722.

# HISTORY OF TRANSISTORS VOLUME 1

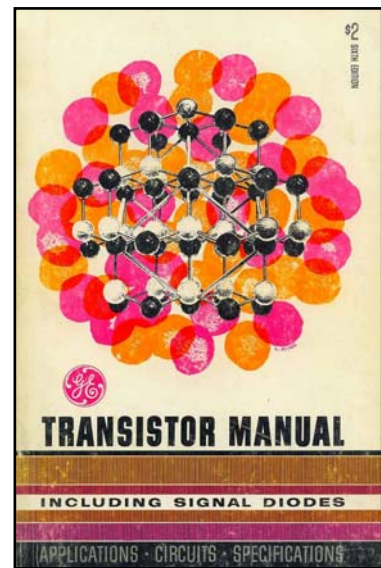
## The First Germanium Hobbyist Transistors

### GENERAL ELECTRIC (1950s - 1970s)

General Electric (GE) was an early semiconductor device leader, beginning in the late 1940s with point contact transistors and germanium diodes. Building on extensive research, engineering and manufacturing organizations, GE became a major supplier of transistors in the 1950s, and maintained this leadership position into the 1960s. The first GE junction transistors were introduced in mid 1953, with the very successful 2N43/44/45 line of alloy junction devices. These were rugged, reliable transistors enclosed in the now classic "pinched top" metal case. In 1955, GE introduced the 2N107, which was a low cost transistor intended for the hobbyist market. The original 2N107s were "leftovers" from the same production lines as the 2N43/4/45 (the lowest performing units were sold as 2N107). General Electric introduced the 2N170 in June 1956. According to the press release which announced the 2N170, "A new high frequency transistor for radio hobbyists and do-it-yourself devotees, priced about the same as its nearest comparable electron tubes, was announced... Designated the 2N170, the new transistor is the second in a series of transistors especially designed by GE for use by electronic hobbyists". Both the 2N107 and the 2N170 became favorites with hobbyists and experimenters, and many articles appeared in the electronics magazines of the time with projects using these transistors. GE sold 100,000s of these devices to eager hobbyists, and actively promoted this market by publishing booklets and schematics which provided interesting experimenter applications for the transistors. GE maintained a presence in the hobbyist market into the 1970s, even when the overall commercial transistor business for GE began to wane.



The distinctive "pinched top" case style was used by GE for early transistors.



GE is likely best remembered by electronics hobbyists and engineers because of the very popular series of GE "Transistor Manuals", which began in the mid 1950s with an innovative 62 page 1<sup>st</sup> edition and ended with the 670 page 7<sup>th</sup> edition in 1964. Shown above is the cover of the 1962 6<sup>th</sup> edition.

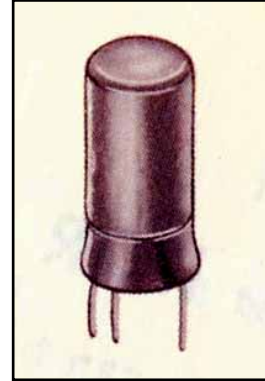


# HISTORY OF TRANSISTORS VOLUME 1

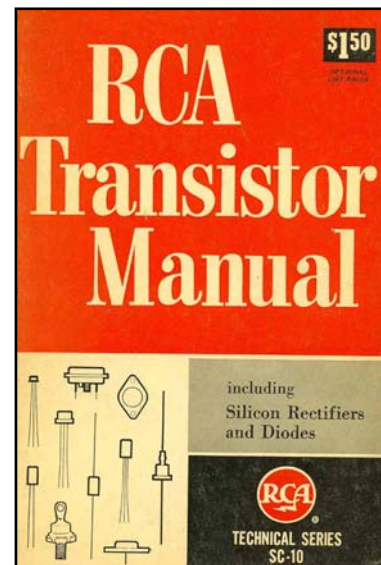
## The First Germanium Hobbyist Transistors

### RCA (1950s - 1970s)

RCA was a top tier electronics company in the 1950s, with a leadership position in most areas of the industry, including vacuum tubes, defense, communications and the rapidly expanding field of consumer products, including radio and television. Shortly after the introduction of the transistor in 1948, RCA initiated an extensive semiconductor research program at RCA Labs in Princeton N.J. By 1953, RCA was producing transistors at the Harrison N.J. vacuum tube facility. Large scale production of transistors was in place by 1955, with most of the devices destined for use in commercial radios. These early RCA transistors were germanium PNP alloy devices, such as the 2N109, best suited for audio and low freq general purpose applications. Prior to the appearance of transistors, RCA had maintained an active presence in the ham radio market, primarily as a means of enhancing the sales of vacuum tubes. This general approach was extended to with the new transistor technology, with RCA developing hobbyist and experimenter publications to enhance the sales of these new devices. The 2N109 was ideally suited for this hobbyist market and was heavily promoted by RCA for use in such hobbyist type projects as audio amplifiers, radios, preamps, and code practice oscillators. RCA continued to support the transistor hobbyist market throughout the 1950s, 1960s and 1970s, with numerous publications and kits. The 2N109 remained the primary RCA hobbyist device, although later products, such as integrated circuits and Nuvistor vacuum tubes, were also promoted.



The first RCA hobbyist transistors (2N109) were produced with a unique black epoxy case, with a flared lower header.



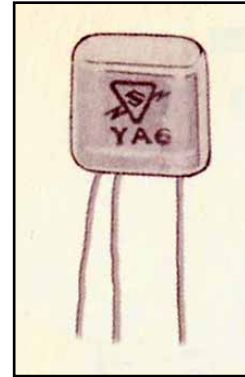
This is the cover of the 1962 RCA Transistor Manual, primarily intended to promote the use of RCA transistors in the experimenter and hobbyist market. Theory, specifications and circuits are presented in 305 pages.

# HISTORY OF TRANSISTORS VOLUME 1

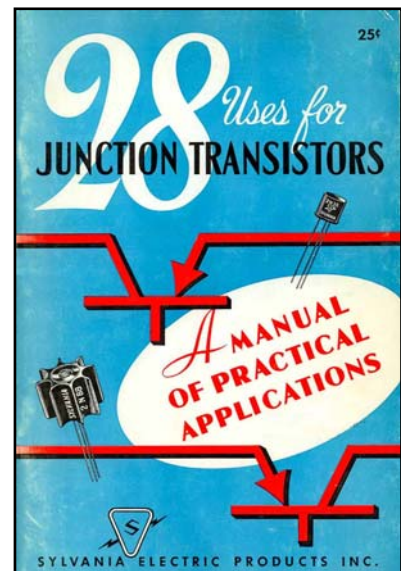
## The First Germanium Hobbyist Transistors

### SYLVANIA (1950s - 1980s)

Sylvania had established a large scale vacuum tube manufacturing presence just at the time when transistor technology was introduced. In addition, Sylvania was an active supplier of silicon radar mixer diodes, such as the 1N21, to the US military during WWII. Building on this expertise, Sylvania introduced the first commercial germanium crystal diode, the 1N34, in 1946. This device was heavily marketed to the hobbyist market and established Sylvania as the premier germanium device supplier. Soon after the announcement of the transistor in 1948, Sylvania launched a major development effort to enter the commercial transistor market. After some initial work with point contact types, such as the 2N32 and the 2N33, Sylvania was most successful with the 1953 launch of the 2N34 and 2N35 general purpose audio transistors. Because of the popularity of the 1N34 diode, and the large number of hobbyist projects and booklets devoted to this device, Sylvania was well suited to use the same approach for transistors. The 2N35 became a favorite transistor for hobbyists and experimenters in the 1950s, and numerous articles and booklets were published using this device. Other Sylvania transistors used by hobbyists included the 2N68, 2N94, 2N95 and 2N229. Although Sylvania was a dominant supplier of germanium transistors, the company was not successful in the silicon transistor or integrated circuit market. However, Sylvania did maintain an important role in germanium technology for hobbyists by establishing the ECG line of replacement transistors which were used by electronics amateurs, hobbyists and professionals throughout the 1960s, 1970s and 1980s.



Above is an illustration of the silver metal case Sylvania hobbyist transistor style used in the mid to late 1950s. The earliest units were black.



This is the cover of the 1955 Sylvania Transistor Manual, developed to provide practical circuits for experimenters. This first booklet was soon followed by a series of related transistor publications into the 1960s.

# HISTORY OF TRANSISTORS VOLUME 1

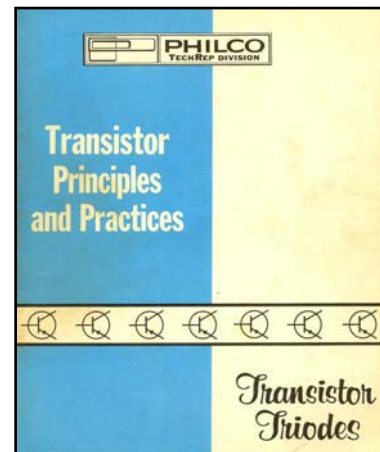
## The First Germanium Hobbyist Transistors

### PHILCO (1950s - 1960s)

Philco is best remembered by transistor hobbyists for developing the surface barrier transistor, which was a unique technology that made a revolutionary impact on high frequency applications such as radio receiver circuits. In 1953, Philco announced the commercial release of surface barrier transistors (SBT) such as the SB100 series. Although intended primarily for the military, the SBT technology was quickly adopted by transistor hobbyists because of the exceptional high frequency performance offered by SBT devices. While other available transistor types in the mid 1950s would operate at only a few MHZ, the SBTs of the time would perform well at 30 MHZ and above. This was ideal for transistor radio applications, such as simple regenerative receivers, and numerous projects of this type appeared in hobbyists publications in the 1950s. Philco was also an active manufacturer of commercial electronics products, such as radios and televisions, and soon employed the SBT technology in these products. In fact, the first commercial all transistor television was developed by Philco in the late 1950s, and used SBTs. Another important commercial product for Philco was the Transac line of digital computers, developed in the 1950s - the high speed switching performance of these computers was based on the SBT technology. Philco never directly marketed to electronics hobbyists, but the unique performance characteristics of SBTs, such as the SB100 series, the 2N128, the A01 and the L-series found widespread use in hobbyist projects throughout the 1950s and 1960s. Philco was active in supplying products to the US military and established a worldwide Field Support and Training organization which published numerous transistor technology educational booklets.



Philco SBTs (Surface Barrier Transistors) are easily recognized by the unique "bullet" shaped case style - used in the 1950s and 1960s.



This 1960 publication is an example of the educational material developed by Philco to support the TechRep Field Service organization. Other publications included a 1956 Handbook of Tubes and Semiconductors and a 1960s Digital Computer Lab Manual.

# HISTORY OF TRANSISTORS VOLUME 1

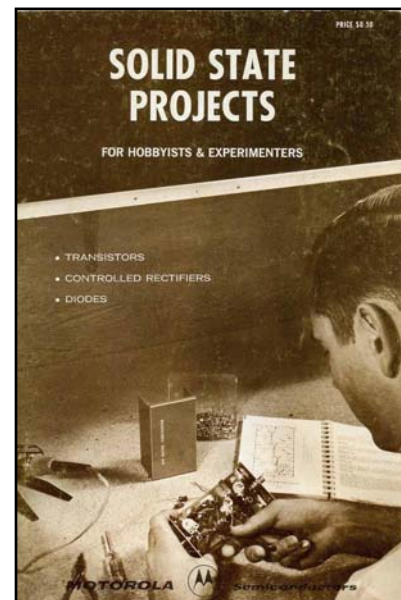
## The First Germanium Hobbyist Transistors

### MOTOROLA (1960s - 1980s)

In the early 1950s, Motorola established a semiconductor research facility in Phoenix, with the purpose of developing the processes required for commercial transistor manufacture. By 1957, Motorola was an industry leader in germanium power transistor production, with millions of units sold for use in automobile radios. In the 1960s, Motorola invested heavily in integrated circuit technology and became a dominant presence in this technology as well. In the mid 1960s, Motorola entered the electronics hobbyist market in a big way, with the introduction of the HEP line of semiconductors, which were developed specifically for the experimenter/hobbyist market, and supported by a continuing set of manuals and booklets with a wide variety of circuit applications for HEP devices. The original HEP products were discrete components, such as germanium transistors and diodes, but the HEP line was soon expanded to include integrated circuits as well. By the 1970s, Motorola had become a major supplier of hobbyist semiconductors with hundreds of products and numerous booklets and publications. In addition, the HEP product line was extended to include "universal replacement" devices for use by electronics repair technicians. Motorola was unique among other major semiconductor companies of the integrated circuit era (TI and Fairchild, for example) because of its commitment to the hobbyist market. The HEP product line continued into the 1980s, and many hobbyists still remember their introduction to electronics with these unique Motorola products.



Motorola sold the HEP line of hobbyist and replacement semiconductors in colorful packaging, as above, with device specifications included.



Shown above is the 1964 Motorola Solid State Projects Manual, developed to support the new HEP product line.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

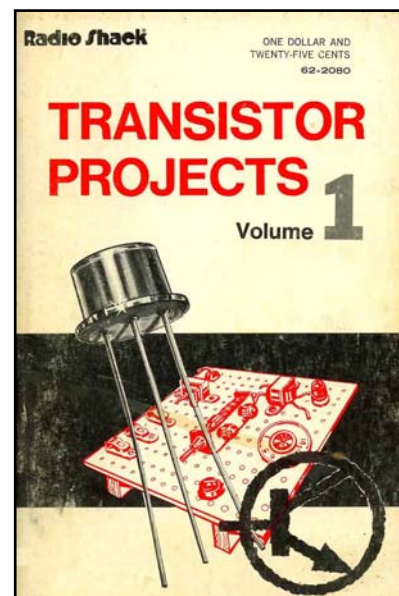
### RADIO SHACK (1950s - 2000s)

(Lafayette Radio, Allied Radio, Burstein-Applebee, Olson)

There were several nationally known companies in the 1950s which specialized in hobbyist electronics products, including kits, parts, and commercial audio and radio sets. A list of the best known of these companies would include Radio Shack (Archer), Lafayette Radio, Allied Radio, Burstein-AppleBee and Olson Electronics. Radio Shack was one of the first to enter the hobbyist transistor market, when it announced availability of the Raytheon CK722 transistor in 1953. Throughout the remaining years of the 1950s, there was quite a bit of excitement among hobbyists as each of these companies would compete to provide a wider selection of transistors, at lower prices. The \$1 per transistor threshold was reached first with the CK722, and then later with the GE 2N107. It was also common in these early days of transistor technology for hobbyist companies to provide "late-breaking" updates in their catalogues as new models were developed. Lafayette was very active in developing complete hobbyist kits, often in collaboration with well-known construction project writers of the time. Beginning in the 1960s, as transistor prices dropped and there were large surplus inventories, especially of early germanium transistors, it become common for these companies to offer "bargain packs" with large numbers of transistors for a low cost. This theme was repeated in the 1970s when IC prices dropped. There was quite a bit of consolidation of these companies over the years. Radio Shack has remained the best known and most successful of these companies - even today, you can likely walk down to your local Radio Shack and buy a bargain pack of transistors.



Here is an example of "bargain-pack" transistors from 1960s Radio Shack.



Radio Shack published a large number of transistor circuit hobbyist books - the above is from 1973.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### BIBLIOGRAPHY OF EARLY TRANSISTOR REFERENCE MATERIAL AND CLASSIC TRANSISTOR HOBBYIST PUBLICATIONS

This bibliography provides additional information regarding the technical material that has been referenced in your booklet. Many of these publications are no longer in print, but you should be able to find most of them through online auctions or online vintage book sellers. All are highly recommended and provide a comprehensive view of the world of the early transistor hobbyist.

- [1] Hunter, L.P., *Handbook of Semiconductor Electronics*. New York: McGraw Hill, 1956. Comments: This is an excellent text for introducing the modern reader to the world of mid-1950s transistor technology. This is a classic, and although not written at the typical hobbyist level, the extensive bibliography and frequent use of diagrams and photos makes this a "must-have" for those interested in early transistor history.
  
- [2] Riordan, M., Hoddeson, L., *Crystal Fire - The Birth of the Information Age*. New York: W.W. Norton & Co. 1997. Comments: This is a modern classic, and provides a really comprehensive overview of the development of the transistor. Very readable, with much information of interest to the transistor hobbyist.
  
- [3] *Proceedings of the IEEE, Special Issue: 50<sup>th</sup> Anniversary of the Transistor*. January 1998, Vol 86 No 1. Comments: This Special Issue of the IEEE Proceedings is another "must-have" for transistor hobbyists and historians. There are reprints of original transistor historical articles, as well as current commentary - a wealth of information.
  
- [4] *Servicing Transistor Radios, Vols 1 and 2*. Indianapolis: Howard W. Sams & Co. 1958. Comments: This is a multi-volume series of transistor radio repair manuals, published in the 1950s and 1960s, which provides extensive information regarding early transistor radios, circuits and repair tips. The first two volumes in the series contain additional information about early transistor technology; very useful for hobbyists.

## HISTORY OF TRANSISTORS VOLUME 1

### The First Germanium Hobbyist Transistors

- [5] *Raytheon Transistor Applications, More than 50 Practical Circuits Using Raytheon CK722 Transistors.* Raytheon Manufacturing Co., Receiving and Cathode Ray Tube Operations. 1955. Comments: This is the first and best known of the early transistor hobbyist books. It was published by Raytheon to promote the famous CK722 transistor, and the book contains over 100 pages of CK722 projects that were reprinted from hobbyist magazines of the time. If you have only one book in your collection, this should be that book.
- [6] *Raytheon Transistor Applications, All New Circuits, Volume II.* Raytheon Manufacturing Co., Receiving and Cathode Ray Tube Operations. 1957. Comments: Building on the success of the CK722 Transistor Application book, Raytheon published a Volume II book of transistor applications, with more projects - this volume documented the use of additional Raytheon transistors, beyond the CK722. Also includes basic transistor theory, circuit design tips and reference data.
- [7] *General Electric Transistor Manual. Volumes 1-7.* General Electric Semiconductor Products Department. 1956 - 1964. Comments: This series of Transistor Manuals is likely the best known of all hobbyist publications from the 1950s and 1960s. The first volume, from 1956, was a mere 61 pages, and contained a very comprehensive discussion of the state of the art in germanium transistor technology. The final volume, 7<sup>th</sup> edition, appeared in 1964 and was an impressive 670 pages. All editions contain "build it yourself" hobbyist projects.
- [8] *RCA Transistor Manual.* RCA Semiconductor and Materials Division. 1962. Comments: RCA was a leading semiconductor company in the 1950s and 1960s, and had long been active in the earlier vacuum tube hobbyist market. The 305 page 1962 RCA Transistor Manual provides a comprehensive overview of transistor theory, specifications and numerous hobbyists circuits.
- [9] *28 Uses for Junction Transistors,* Sylvania Electric Products, Inc. 1955. Comments: Sylvania was very active in the 1950s transistor hobbyist market, publishing numerous manuals, and offering low cost kits through distributors. This 1955 booklet was the first of many Sylvania hobbyist publications to appear over the next decade - each is filled with interesting circuits and projects.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

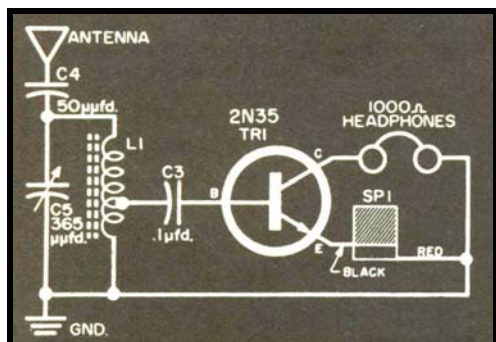
- [10] *Transistor Principles and Practices - Transistor Triodes.* Philco TechRep Division. 1960. Comments: Philco was the major supplier of high frequency germanium transistors in the 1950s, taking the lead early in 1953 with the surface barrier transistor (SBT). Philco did not market directly to hobbyists, but the SBT was widely used by experimenters in radio and computer projects. Philco did publish numerous transistor booklets which were intended for use by the world-wide Philco service organization - this 45 page 1960 booklet is an example, which contains general transistor and SBT information.
- [11] *Solid State Projects for Hobbyists and Experimenters.* Motorola Semiconductor Products, Inc. 1964. Comments: Motorola entered the transistor hobbyist market in the early 1960s with the well known HEP line of semiconductors and publications. Beginning with HEP transistors (as in this 62 page 1964 booklet), Motorola became a major semiconductor hobbyist company in the 1960s and 1970s with numerous HEP devices and construction projects/booklets.
- [12] *Transistor Projects, Volumes 1-3.* Radio Shack. 1973. Comments: Radio Shack became the first electronics distributor to enter the transistor hobbyist market by offering the famous Raytheon CK722 transistor in 1953. Over the next five decades, Radio Shack continued to provide hobbyist semiconductor devices and construction project books. The 1970s three volume series, Transistor Projects, was a favorite for many experimenters, and was the first of a series of highly successful Radio Shack books authored by Forrest M. Mims III.
- [13] *Popular Electronics, Radio & TV News, Radio Electronics.* Comments: Electronics experimenters and hobbyists from the 1950s through the 1970s will well remember the excitement of receiving the next monthly issue of one the three leading construction project magazines listed above. These classic publications contained industry news, product reviews, numerous construction projects and countless ads from distributors offering "must have" transistors at affordable prices. Vintage editions of these magazines are readily available and remain the best source of classic transistor hobbyist information.



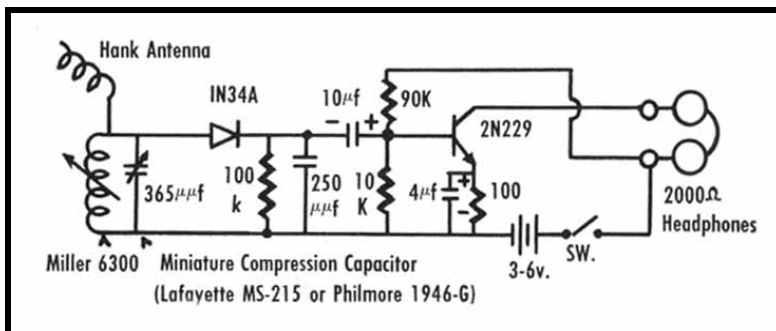
# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### NEXT STEPS - HISTORIC TRANSISTOR PROJECTS TO BUILD

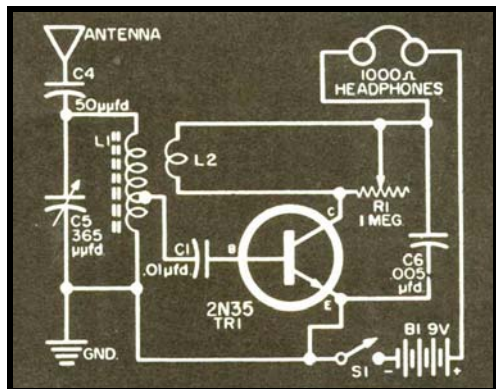


Sun-Battery Receiver



One-Transistor Pocket Radio

Above circuit from "Performance-Tested Transistor Circuits",  
Copyright © 1958 by Sylvania Electric Products, Inc.



Regenerative Receiver

The 2N35 Sylvania transistor was an early favorite with hobbyists. Shown above is a 1957 circuit from a Sylvania publication of popular transistor projects. This is a simple, but adequately performing radio receiver, using a 2N229 transistor. The 2N229 transistor was a low-cost version of the 2N35, intended to be affordable to young 1950s experimenters. Your 2N35 should work just fine!

Shown at left are two interesting 2N35 projects advertised by Lafayette Radio, which was a well known 1950s electronics parts supplier. At top left is a "Sun-Battery" receiver, which was developed to demonstrate the very low power requirements of the new transistor technology. You could buy all the parts, including the well-remembered International Rectifier "Sun-Battery" directly from Lafayette. The next circuit (at left) is a higher performing radio receiver, using a regenerative circuit design which allowed much greater amplification from a single device - "regen" receivers date back to the 1920s, when vacuum tube technology was new. All parts used in these three radio receivers are still easily obtainable and your 2N35 transistor would be an authentic addition. Note that you could also use your other NPN device, the GE 2N170, in these circuits, and might even achieve better performance in the "regen" receiver with the 2N170 due to the higher frequency performance of the GE transistor.

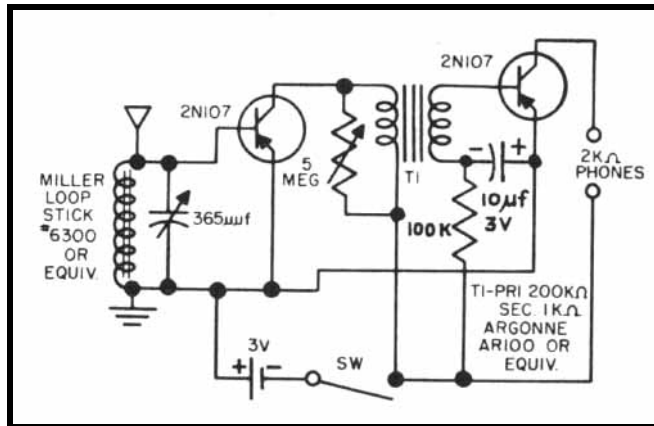


Above circuits and graphics adapted from a mid 1950s Lafayette Radio catalogue insert.

# HISTORY OF TRANSISTORS VOLUME 1

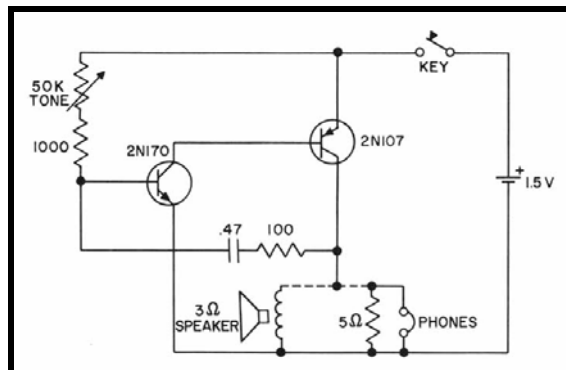
## The First Germanium Hobbyist Transistors

### NEXT STEPS - HISTORIC TRANSISTOR PROJECTS TO BUILD



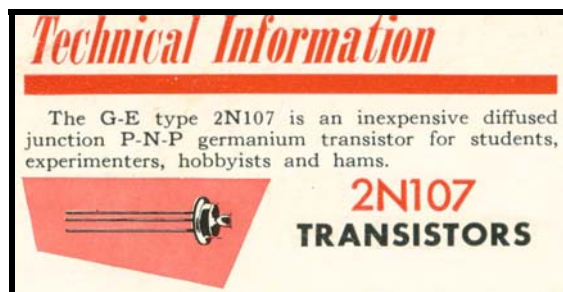
### Two-Transistor Radio Receiver

Above circuit from "Transistor Manual, First Edition",  
Copyright © by General Electric Company.



### Code Practice Oscillator

Above circuit from "Transistor Manual, Sixth Edition",  
Copyright © 1962 by General Electric Company.



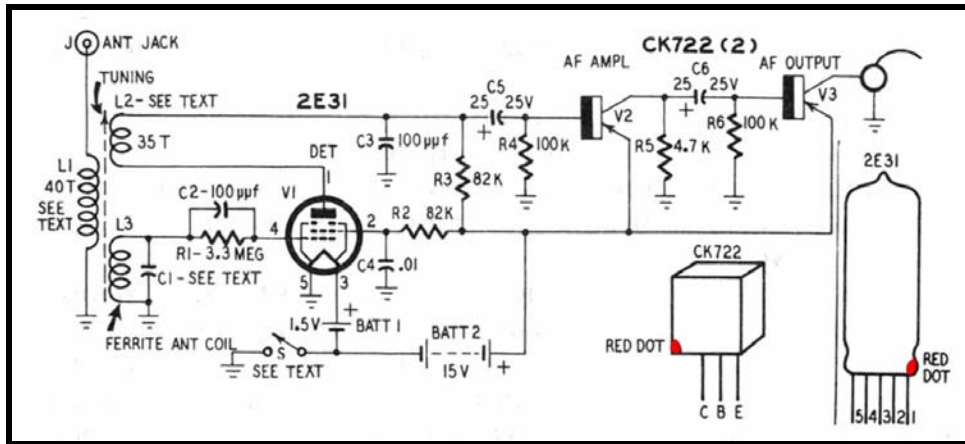
Above is a section of an early announcement of the 2N107 - this is from the June 1956 GE Ham News.

General Electric was an early and leading manufacturer of germanium transistors. GE had quite a bit of previous experience with selling vacuum tubes to electronics hobbyists, and used this same approach for transistors. The 2N107 (PNP) and 2N170 (NPN) were introduced in the mid 1950s, with the hobbyist in mind. To support this market, GE published a series of highly regarded "Transistor Manuals", beginning in the mid 1950s. Shown on this page are sample transistor hobbyist projects from the First and Sixth editions of the GE "Transistor Manual". These circuits feature the very famous 2N107 and 2N170 hobbyist transistors. These two projects use standard and readily available components and should be simple to build. The radio receiver (shown above left) could be built with your 2N107 and your CK78X - both PNP devices. The code practice oscillator produces an interesting audio tone and can be used as a demonstrator for your transistors, or to test other germanium transistors you might acquire, either PNP or NPN, since both polarities are required in this circuit.

# HISTORY OF TRANSISTORS VOLUME 1

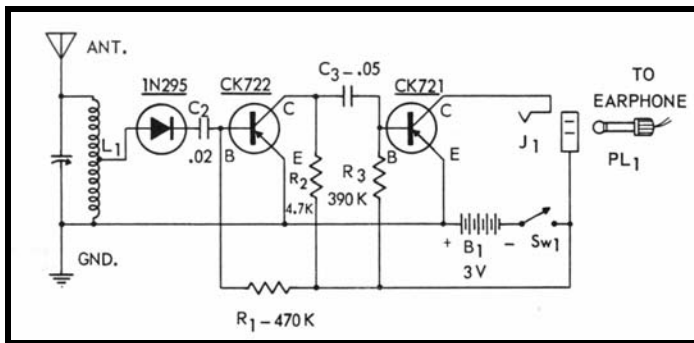
## The First Germanium Hobbyist Transistors

### NEXT STEPS - HISTORIC TRANSISTOR PROJECTS TO BUILD



### "Transitube" Pocket Radio

Above circuit from "Transistor Projects",  
Copyright © 1960 by G/L Tab Books.



### Two-Transistor Receiver

Above circuit from "Volume II, Transistor Applications"  
Copyright © 1957 by Raytheon Manufacturing Co.



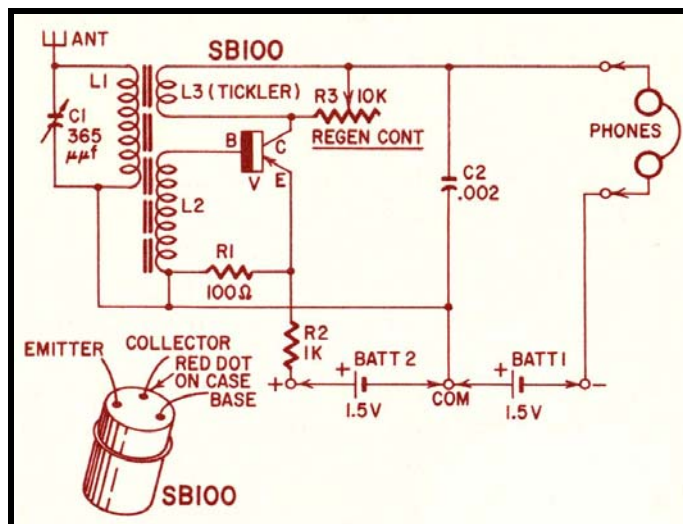
This is a photo of the classic Raytheon 1950s foldover cardboard packaging for the CK722 - inside would be an iridescent blue or shining silver transistor.

Just prior to the commercialization of transistors in the 1950s, subminiature vacuum tubes were in large scale production, including low voltage audio types suited for the hearing aid market. Shown above is a very interesting radio circuit, developed by Homer L. Davidson and published in the Radio Electronics magazine. This is a "hybrid" radio, meaning that both vacuum tube and transistor technology is used. The 2E31 tube is a low voltage hearing aid type and the two transistors are both CK722 types - likely the most famous hobbyist transistor of all time. Speaking of the CK722, shown at left is a radio receiver reproduced from a late 1950s Raytheon publication devoted to transistor applications. If you are fortunate enough to acquire original Raytheon semiconductors for this project, you'll have a very colorful result - bright blue Raytheon transistors and red-cased 1N295 diode. If you want to use the hobbyist transistors supplied with this Volume 1, you can use the two PNPs (CK78X and 2N107) and substitute the base-emitter junction of the 2N170 for the 1N295 diode.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### NEXT STEPS - HISTORIC TRANSISTOR PROJECTS TO BUILD



### "Transitube" Pocket Radio

Above circuit from "Transistor Projects",  
Copyright © 1960 by G/L Tab Books.

**PHILCO TRANSISTORS (PNP)**

Type	Max Dis Mw	Max Col V	Max Col Ma	Min Cur Gain	Min Cut-Off Mc	Use	Net Each
SB-100	10	-4.5	5	20	45	HF*	3.90
SB-200	20	-4.5	5	7	15	HF*	1.50
2N128	25	-10	5	66†	45	HF*	6.30
2N207	50	-12	20	35	2	LL	1.95
2N207A	50	-12	20	35	2	LL	2.10
2N207B	50	-12	20	35	2	LL	2.25
2N223	200	-18	150	120†	.6	AF	1.08
2N224	250	-25	150	65	.5	AF	1.10
2N225	Matched Pair of 2N224's					AF	2.55
2N226	250	-30	150	35	.4	AF	1.02
2N227	Matched Pair of 2N226's					AF	2.28
2N240	30	-6	15	16	25	OSC*	5.93
2N299	20	-5	5	5	90	HF*	14.00
2N300	20	-5	5	11	85	HF*	15.00
2N344/ SB101	20	-5	5	33†	30	OSC*	3.45
2N345/ SB102	20	-5	5	110†	30	OSC*	4.35
2N346/ SB103	20	-5	5	10	60	OSC*	5.85

### "Philco Transistor Specs and Prices"

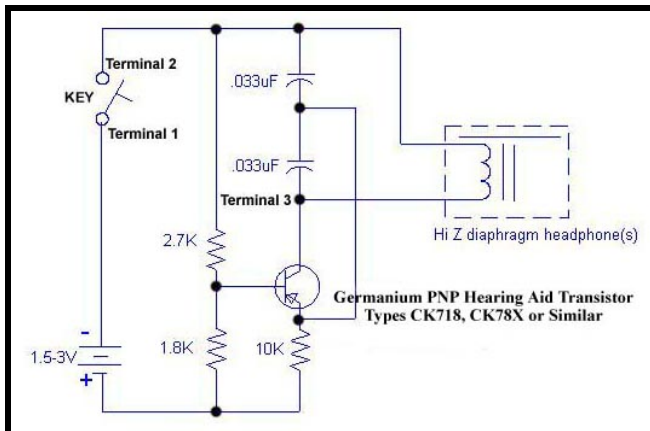
Above scan is from the 1960 Lafayette Radio  
Semi-Conductor Directory.

The Philco Surface Barrier Transistor (SBT) was the "hottest" transistor around until the late 1950s. This device performed very well at high frequencies and was used extensively in radio and computer circuits. Hobbyists were delighted to find such an inexpensive high frequency device. Shown above is a simple, but very sensitive regen radio using a Philco SB-100 SBT. This circuit was developed by Edwin Bohr and first published in the Radio Electronics magazine. Mr. Bohr authored many well-remembered transistor construction projects in the 1950s/60s. This one transistor receiver is an extremely impressive performer, primarily due to the unique characteristics of the SBT technology. Shown at left is information and prices for Philco transistors from a 1960 Lafayette Radio publication. Note that all devices on this list shown with a "\*" symbol in the Use column are SBT types. The \$3.90 price for a SB-100 was likely several weeks allowance for a young hobbyist in 1960!

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### NEXT STEPS - HISTORIC TRANSISTOR PROJECTS TO BUILD



Shown at right is the Valandy Code Oscillator, in the original presentation case and earphone. This is most likely the first transistorized code oscillator sold to the public and dates from 1954/55. The original circuit used surplus CK718 Raytheon hearing aid transistors. The Valandy circuit above is a classic "Colpitts" oscillator and produces a very pleasing pure audio tone. You can use your CK78X Raytheon hearing aid transistor to develop an authentic modern version of this historic project. The original Valandy Code Oscillator used a small black plastic case, and was supplied with a high performance earphone.



Shown here is the original oscillator, in overall presentation case and with your CK78X transistor envelope shown for size comparison. The photo at the top of this page illustrates a modern day reconstruction of the Valandy circuit. You can find complete details for this project at: <http://www.transistormuseum.com>.

# **HISTORY OF TRANSISTORS VOLUME 1**

## **The First Germanium Hobbyist Transistors**

### **NEXT STEPS - INTERESTING THINGS TO DO**

**Start a Collection** - Adding to the historic hobbyist transistors included with this Volume 1 of "The History of Transistors", an excellent next step would be to research, locate and acquire examples of the hundreds of types of early devices identified in the references. Building your own personal collection of a well-researched variety of devices important to the history of transistor technology could provide immense educational value for years to come. You'll find preprinted storage and display envelopes for your new collection in the final insert sheet at the back of this book.

**Research a Specific Company or Type of Transistor** - After you've started a basic collection of early transistor types, an excellent next step would be to expand the collection with emphasis on a particular historic company of interest or a specific type or number range of devices. For example, the earliest transistors were labeled with the 2NXX numbering system, such as 2N35, and a suggested research strategy might be to identify and collect the complete range of devices from 2N21 to 2N99. Another approach might be to collect the complete range of known "2N" types from pioneering germanium transistor companies such as Sylvania or General Electric.

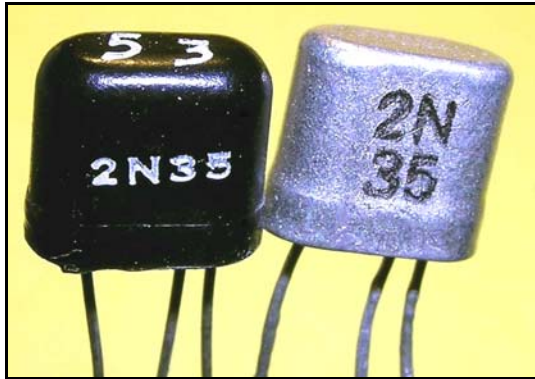
**Build a Modern Replica of an Early Kit or Historic Construction Article Project** - With the wealth of historic online or Ebay documentation now available, (for example, review a copy of Popular Electronics magazine from the late 1950s), it is possible to build a modern version of a historic kit or vintage construction article project. Use the circuits that have been documented in the preceding pages as a starting point. Radios, oscillators, and early digital circuits are all easily built and can be done with the same vintage components and style from the early days.

**Check Back Often at the Transistor Museum** - New material is added to the Museum site on a regular basis. Check the website often to see the latest Oral Histories, Construction Projects, Photo Gallery and Museum Store updates. More History of Transistor publications are planned.

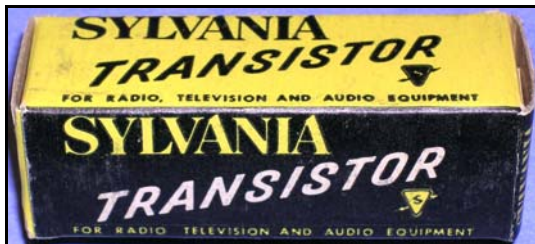
**The reminder of this book contains detailed photo material about your transistors, your five historic transistors, and additional storage and display envelopes to allow you to expand your collection of historic transistors.**

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors



Transistor Size (1/4"L X 1/8"W X 1/4"H)  
Date Code 53 on Top



Cardboard Vacuum Tube Style Packaging Used  
for Early 2N35 Commercial Devices

## SYLVANIA 2N35

### TYPE

Germanium NPN Alloy Junction  
Audio Amplifier

### USAGE

Hobbyist/Experimenter  
Early Commercial Radio

### DATE INTRODUCED

1953

### CASE STYLES

Black Metal (Early)  
Silver Metal (Later)

### AVAILABILITY

Common (High Volume Production)

### HISTORIC NOTES

The Sylvania 2N35 was one of the early transistors most commonly used by hobbyists/experimenters in the 1950s. Unlike most inexpensive transistors, the 2N35 is an NPN type, and this made it ideally suited for many circuits combined with the more common PNP types (such as the Raytheon CK722 and the GE 2N107). Sylvania marketed the transistor, along with a companion PNP 2N34, directly to the hobbyist/experimenter market by publishing transistor project construction booklets and even kits containing the 2N35. The 1955 Lafayette catalogue lists the 2N35 as available for \$4.30. A kit containing two 2N35s, one famous 1N34 germanium diode, and the booklet "28 Uses for the Junction Transistor" was listed for only \$4.45. Although the 2N35 was primarily advertised for use in hobbyist construction projects, this device was also used in commercial products, at least for a short time. Early versions of the famous Zenith Royal 500 transistor radio, introduced in 1955, used the 2N35 in the audio circuitry. In the late 1950s, Sylvania introduced the 2N229 as a lower cost version of the 2N35, and published hobbyist project notes for this low cost device.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### SYLVANIA 2N35

**High-Gain, Low Frequency**  
 —2N35 (NPN)—2N34 (PNP)—low to medium power—use as a high-gain audio amplifier—gains up to 40 in grounded emitter circuit.



Sylvania promoted the use of its line of early germanium transistors with a 1955 construction booklet entitled "28 Uses for Junction Transistors." The scan above is a section of the back cover of this booklet, which provides some interesting performance details of Sylvania's early line of germanium transistors - also listed on the back cover are the 2N34 (audio PNP), the 2N68 (power PNP), 2N95 (power NPN), and 2N94 and 94A (high frequency NPN). The booklet contained construction projects using these early Sylvania transistors. Shown below is an audio amplifier circuit from the booklet - it is similar to the commercial use of the 2N35 in the audio section of the Zenith Royal 500 radio.



**SYLVANIA TRANSISTOR KIT**

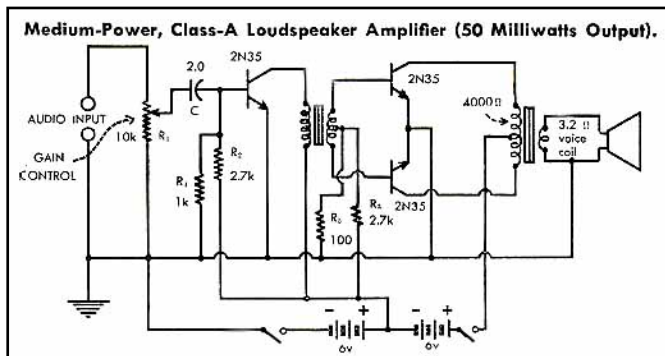
**COMPLETE KIT 4.45**

**For The Experimenter**

The Sylvania Transistor Kit is supplied with the Transistor Booklet "28 USES FOR JUNCTION TRANSISTORS," TWO Type 2N35 Transistors and one type 1N34A General Purpose Diode. Complete transistor circuits and detailed instructions make this kit easy to use. Ideal for the experimenter who wants to get the feel of transistorized circuits.

**KIT ..... Complete Kit 4.45**

Sylvania was apparently very interested in developing and selling to the transistor hobbyist/experimenter market, building on earlier success in this area with the 1N34 and 1N34A germanium diodes, beginning in 1946. To that end, Sylvania developed a series of booklets and kits designed for this market. The first Sylvania transistor hobbyist kit appeared in 1955 and is shown above in an ad from the Lafayette Radio catalog of that same year. This was quite a bargain, with two 2N35 transistors, one 1N34A germanium diode and a construction booklet featuring 28 separate circuits for early Sylvania transistors.





# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors



Transistor Size (7/8" OD X 3/8")  
Date Code 5-39 (1955 Week 39) on Back



1960s GE Hobbyist Packaging for 2N107  
BubblePack Contains Transistor and Schematics

### GE 2N107

#### TYPE

Germanium PNP Alloy Junction  
Audio Frequency Amplifier

#### USAGE

Hobbyist/Experimenter

#### DATE INTRODUCED

1955

#### CASE STYLES

Black Metal Pinched Top (Early)  
Black Metal Top Hat (Later)

#### AVAILABILITY

Common (High Volume Production)

### HISTORIC NOTES

General Electric introduced the 2N107 in August 1955. According to the press release which announced the 2N107, "A new transistor, designed to meet the demands of radio amateurs, hobbyists and experimenters for a stable, inexpensive transistor has been placed on the market by the General Electric Co..... the suggested distributor price of well below \$2 for the new 2N107 transistor makes it the least expensive of any transistor currently available." This transistor became a favorite with hobbyists and experimenters, and many articles appeared in the electronics magazines of the time with projects using the 2N107. The earliest units had the distinctive GE "pinched top" metal case style, while later units were made with the black metal "tophat" style. Like many other hobbyist transistors, the 2N107 was originally developed in an effort to find a sales outlet for the large number of marginally performing "rejects" which were common in the early days of germanium transistor production.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

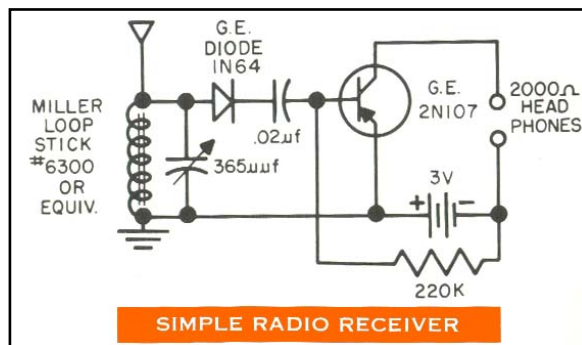


Above is a photo showing the range of case styles of the 2N107 from the 1950s through the 1970s. At right are the two original types, with the early "pinched-top" case from 1955 and the later "top-hat" style from the late 1950s. A rare unmarked "pinched-top" style is shown second from left - this unique appearance resulted from the use of an exhaust tube to allow for creating a partial vacuum inside the transistor case during the manufacturing process. A major second source supplier of the 2N107 (ETCO) used the more standard TO-5 case style into the 1970s (center of photo). At left is an unmarked black 2N107 case style most commonly found in transistor "Bargain Packs" from Radio Shack and other radio parts suppliers. At the top right is an early announcement of the 2N107 - this is from the June 1956 GE Ham News. The 2N107 was a favorite of hobbyists and experimenters, and many "do it yourself" projects were published in electronics magazines. The radio schematic to the right was developed by GE to illustrate one of the favorite hobbyist uses of the 2N107 and first appeared in a small 1955 booklet made available through GE distributors to promote sales of the 2N107.

### GE 2N107

#### Technical Information

The G-E type 2N107 is an inexpensive diffused junction P-N-P germanium transistor for students, experimenters, hobbyists and hams.



#### POPULAR GE TRANSISTORS

GENERAL PURPOSE TYPE 2N107



Diffused junction hermetically sealed general purpose type. For low frequency applications such as radio amplifier, pre-amps, mike circuits, etc. Freq. range to 1 MC. Base amp. factor of 20. Includes wiring diagram and several suggested circuits. **No. 20B51. Each..... 97c**

Above is a scan of an ad from the 1958 Burstein-Applebee catalogue showing details and cost of the 2N107. By the mid 1960s, you could buy surplus hobbyist 2N107s for 10/\$1.00. Radio Shack sold generic, unmarked devices as 2N107s for many years.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors



Transistor Size (1/8" OD X 3/8")  
Standard TO-24 Case



1955 U.S. Army Philco SBT

## Surface Barrier Transistor

### TYPE

Germanium PNP Surface Barrier  
RF/IF/OSC/SW

### USAGE

Hobbyist/High Freq  
Commercial Radio and Computer

### DATE INTRODUCED

1953

### CASE STYLES

Silver or Gold Metal

### AVAILABILITY

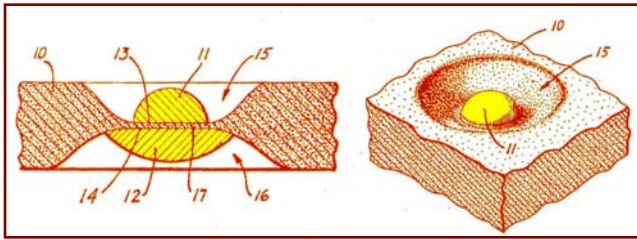
Common (High Volume Production)

### HISTORIC NOTES

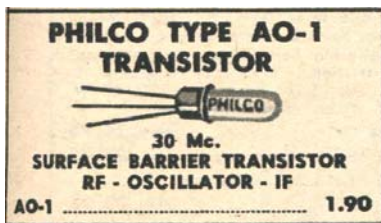
Philco introduced the surface barrier transistor at year's end in 1953. This was very early in the history of transistor technology, and the excellent high frequency performance of this new device ensured that Philco would have a leadership position as a major transistor manufacturer for the next decade. The surface barrier transistor (SBT) found almost immediate acceptance in military and commercial applications, and as prices dropped, these unique transistors found their way into a variety of hobbyist and commercial projects. The top photo shows two of the early commercial SBT types (2N128 and 2N240). The lower photo shows an early (1955, week 13) Philco L-5110 SBT prototype designated for U.S. Army usage. Because of the great success of the SBT, many other companies developed second source versions. Sprague was early to enter this market, followed by CBS, Raytheon, General Transistor and General Instrument; the SBT was manufactured throughout the 1970s. The various SBT model numbers included the 2N128, 2N240, SB100/101/102/103, A01, and the L series.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

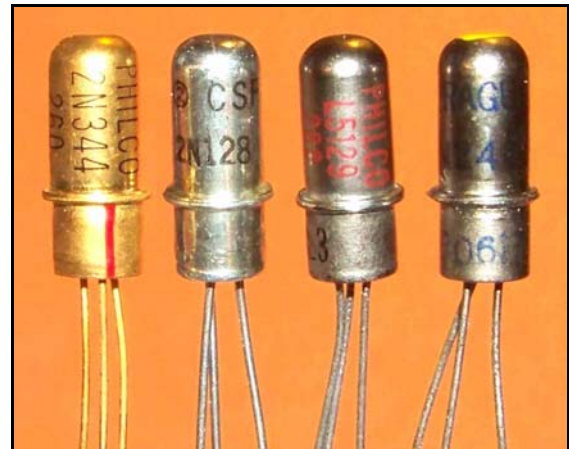


The above photo documents a section of the patent for the surface barrier transistor (#2,885,571), filed in Dec 1954 by R.A. Williams and J. W. Tiley and assigned to Philco Corp. This unique technology uses electro-chemical etching to produce an extremely thin (.2 mil) layer of germanium (#13 above) between the emitter (3 mil diameter - #11 above) and the collector (5 mil diameter - #12 above). This transistor structure allowed for very high frequency operation. Further improvements to this basic technology, using different doping approaches, led to the development at Philco of the MAT (Micro Alloy Transistor) and the MADT (Micro Alloy Diffused Base Transistor); these improved transistors could operate up to the 200 Mhz frequency range. Sprague became a major second source supplier of SBT/MAT/MADT transistors.



Above is a scan of an ad from the 1957 Lafayette Radio Catalogue. The type AO-1 (at \$1.90) and the SB100 (at \$6.00) were the least expensive SBT type available, and became hobbyist favorites. From the same catalogue, the SBT 2N128 (65 Mc and designed for Osc/Conv/Vid) was \$9.00, and the 2N240 (30 Mc, and designed for switching) was \$9.75.

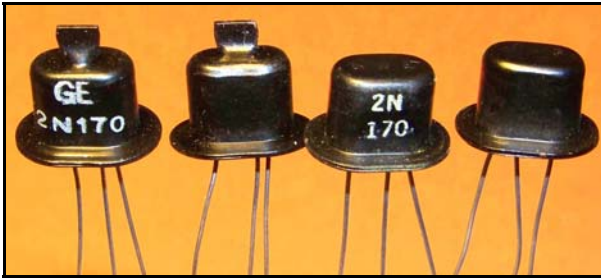
## Surface Barrier Transistor



Philco was the original developer of the surface barrier transistor, but this technology proved so popular that many other companies also made SBTs - shown above are several SBT examples. The gold-plated Philco 2N344 is equivalent to the SB101 and is dated 1959. The Philco L-5129 is dated 1961; the L series transistors were Philco's proprietary inhouse numbering system. The Sprague 2N240, shown above right, is dated 1960, and was one of the best selling SBTs for computer use (the early DEC PDP computer series used 2N240 transistors). Military replacement SBTs, such as the 2N128 above by CSF, were manufactured into the 1970s.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors



Transistor Size (1/2"L X 3/8"W X 3/8"H)  
"Ovals and Pinched Top Ovals"



1950s/60s Radio Shack 2N170 Transistors

## GE 2N170

### TYPE

Germanium NPN Rate Grown Junction  
Radio Frequency Amplifier

### USAGE

Hobbyist/Experimenter

### DATE INTRODUCED

1956

### CASE STYLES

Black Metal Pinched Top (Early)  
Black Metal Top Hat (Later)

### AVAILABILITY

Common (High Volume Production)

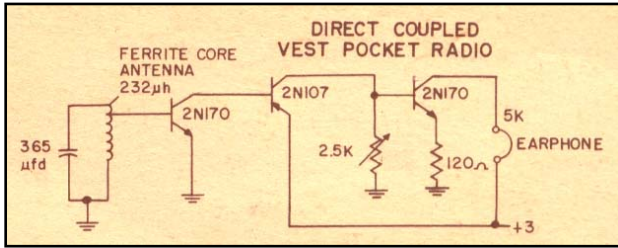
## HISTORIC NOTES

General Electric introduced the 2N170 in June 1956. According to the press release which announced the 2N170, "A new high frequency transistor for radio hobbyists and do-it-yourself devotees, priced about the same as its nearest comparable electron tubes, was announced...Designated the 2N170, the new transistor is the second in a series of transistors especially designed by GE for use by electronic hobbyists. It will amplify radio signals at frequencies up to 4,000,000 cycles. The new GE 2N170 high frequency transistor is being sold at considerably less than \$2." This transistor, along with the previously announced 2N107, became favorites with hobbyists and experimenters, and many articles appeared in the electronics magazines of the time with projects using both these transistors. The 1960 Lafayette Radio Semiconductor catalog lists the 2N170 at \$1.30 each. The earliest 2N170 units had the distinctive GE "pinched top" metal case style with a somewhat unusual "bath-tub" shaped oval base. Later units were made without the "pinched top". These units were very rugged and the hermetically sealed metal cases protected the transistor junctions from moisture and deterioration - most currently existing units are still functional.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

### GE 2N170



Above is one of the schematics included with the original 2N170. The photo on the right is part of the advertising material supplied by GE to distributors when the 2N170 was first announced - the radio shown is the same as in the schematic. Throughout the 1950s and 1960s, the 2N170 was sold in several case styles, which are shown below: the unit on the left below is the original "pinched top" style (note also the unique "bath-tub or oval shape), the second unit from the left is from the late 1950s (same oval shape, but the "pinched-top" is absent) and the two units on the right are later styles, when distributors such as Radio Shack marketed generic NPN RF types as 2N170. Likely these latter were surplus devices that could be bought inexpensively and resold to hobbyists.



**GE TRANSISTORS**

NEW  
RF  
TYPE  
2N170

**\$1.26**

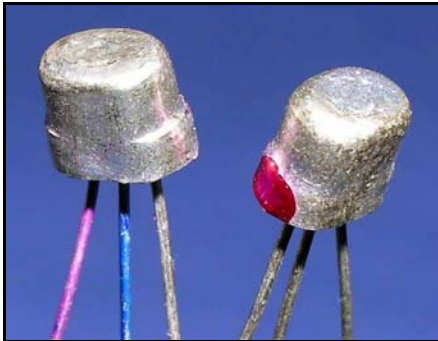
NPN Germanium Transistor intended for use in high frequency circuits. Perfect for building vest pocket radios, regeneration receivers, HF oscillators, etc. Freq. range to 4 MC. Includes wiring diagram and suggested circuits.

No. 20B50. **\$1.26**  
Net Each.....

Above is a scan of part of an ad from the 1958 Burstein-Applebee catalogue showing details and cost of the newly available 2N170. For only \$1.26, you could purchase a "hot" RF transistor!

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors



Transistor Size (1/8"W X 1/8"H)



Date Code 746 on Back (1957 Week 46)

### RAYTHEON CK78X

#### TYPE

Germanium PNP Alloy Junction

#### USAGE

Hearing Aids  
Hobbyist/CK722

#### DATE INTRODUCED

1955

#### CASE STYLES

Silver or Blue Painted Metal

#### AVAILABILITY

Limited (Hearing Aid Usage)

### HISTORIC NOTES

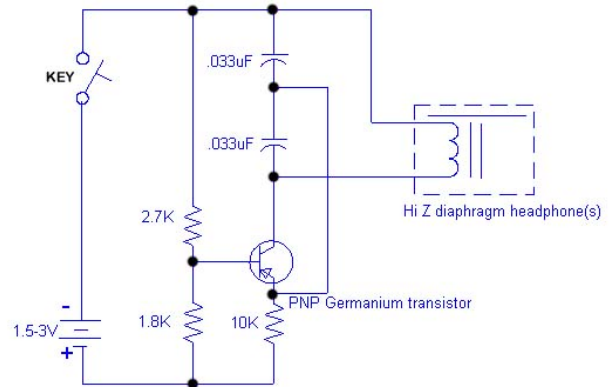
Raytheon was the early leader in the manufacture of germanium transistors, with the largest quantities destined for use in hearing aids. These first Raytheon hearing aid transistors (labeled as CK718) were crudely made devices using a black epoxy case. The epoxy was not an effective seal against moisture penetration, which eventually degraded the performance of the transistors. Raytheon made rapid improvements to their transistor manufacturing processes, and introduced a much more robust, metal cased hearing aid transistor type in 1955, the CK78X series. Each transistor was tested and, based on specific performance characteristics such as gain, noise and leakage, the resultant functioning transistors were labeled with the corresponding model number. As shown above, the blue painted unit was selected and marked as a CK782 and found its way into a hearing aid. Transistors which failed to meet the rigorous hearing aid performance requirements were left unpainted (top photo) and were used by Raytheon to produce the CK722/721 hobbyist line of devices. These unpainted CK78X transistors were encapsulated inside the larger metal case of the CK722/721 type and were sold by the thousands to electronics hobbyists, eager to use these unique devices in their next radio or audio amplifier project.

# HISTORY OF TRANSISTORS VOLUME 1

## The First Germanium Hobbyist Transistors

The photograph shown at the bottom of this page documents the evolution of the first Raytheon hearing aid transistors. On the far right is a type CK718 - this was the first type of hearing aid transistor available in large quantities, starting in 1952, and represents the first large scale production of transistors for commercial purposes. As transistor technology improved, smaller and better performing devices were available for hearing aid use. The two silver units shown at the far left are typical Raytheon transistors from the mid to late 1950s. Raytheon selected only high performing units for hearing aid use, and marketed the remaining lower performing units as "hobbyist" type transistors. The black CK722 (2<sup>nd</sup> from right) is a relabeled CK718. As hearing aid transistors became smaller, Raytheon retained the original case size of the black CK722 by encapsulating the smaller transistors inside a larger metal case. The blue metal CK722 (introduced in 1955) contained a small silver transistor inside, as did the later silver CK722. You can see the gray plastic mounting base of the small transistor on the left - this was inserted into the empty shell of the larger CK722 metal case.

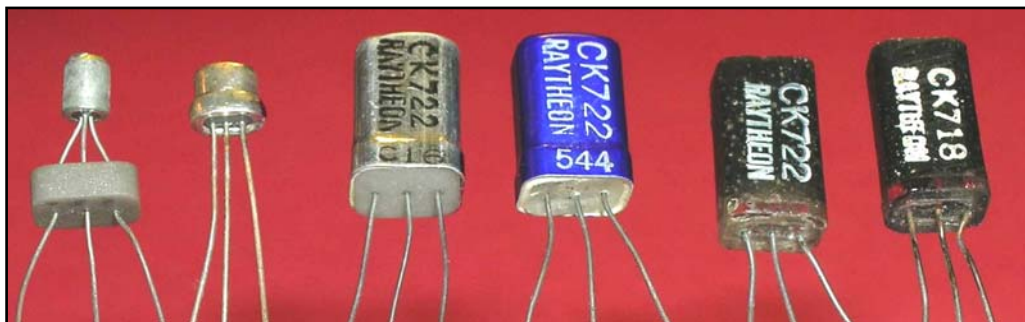
### RAYTHEON CK78X



Typical Application: The schematic above illustrates a typical application for the Raytheon CK78X hearing aid transistor. This circuit is a mid 1950s Code Practice Oscillator, designed and marketed by Valandy Electronics. It was one of the first transistorized hobby projects available and used surplus Raytheon hearing aid transistors.



Shown here is a closeup photo of the four CK78X transistors used in a mid 1950s RadioEar type 850 hearing aid.

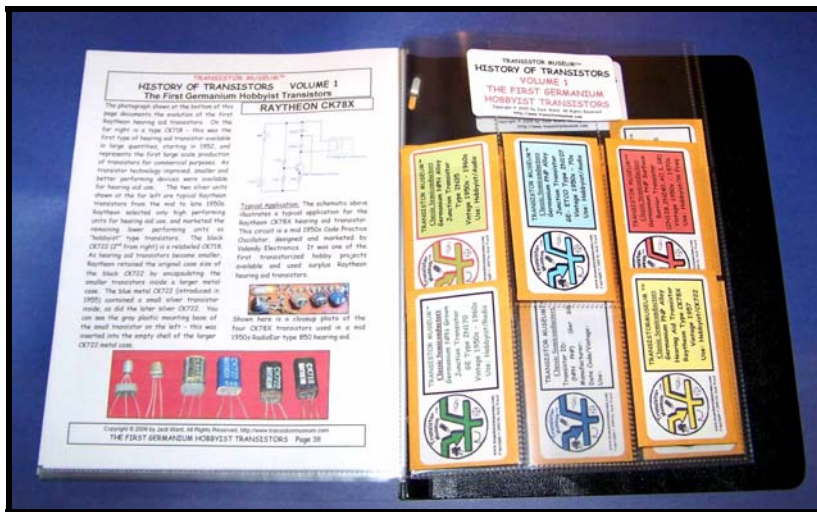




# TRANSISTOR MUSEUM™

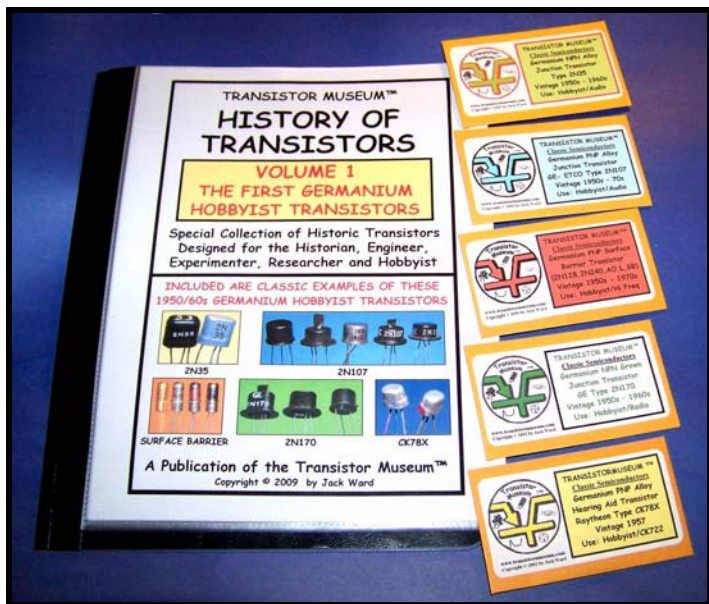
## HISTORY OF TRANSISTORS VOLUME 1 The First Germanium Hobbyist Transistors

If you've enjoyed this web-based pdf version of this History of Transistors Publication, visit the Transistor Museum Store to purchase a hardcopy version, which also includes packaged examples of all five hobbyist transistors as shown below, as well as additional storage/display envelopes for own collection. [http://www.semiconductormuseum.com/MuseumStore/MuseumStore\\_Index.htm](http://www.semiconductormuseum.com/MuseumStore/MuseumStore_Index.htm)



### HISTORY OF TRANSISTORS VOLUME 1

Shown at left is a photo of the booklet, opened to the rear section, which contains the storage sheets for the five hobbyist transistors in display envelopes and the six additional display envelopes provided to assist you in building your own historic transistor collection.



Your historic transistors, photos, descriptive text and storage envelopes are contained in the expandable three-ring report binder as shown above. The display envelopes are securely stored in plastic sheet holders at the rear section of the booklet. Archival quality sheet protectors are used for storage of all pages. For size comparison, the five display envelopes for your historic transistors are shown above, next to the completed Volume 1 binder.

Shown above is a photo of the two types of display envelopes you'll receive. The upper envelope contains one of the five historic transistors (the Surface Barrier is shown) and the lower envelope is one of six empty display envelopes provided for your own use with future research material. All 11 display envelopes can be stored securely in the rear section of the binder.