

TELEVISION PICTURE TUBES (CRT's), BLACK and WHITE COMPONENTS, MANUFACTURING STEPS, USES, DETAILED DESCRIPTION/

INSTRUCTIONS: HOW TO PROCESS A CATHODE RAY TUBE (CRT). COMPONENTS OF THE PICTURE TUBE (CRT):

- a. **GLASS BULB** a/k/a Bulb, Tube, CRT
- b. **ELECTRON GUN**
- c. **PHOSPHOR COATING**
- d. **CONDUCTIVE COATING**, (ELECTRICAL), Liquid-paint (Aquadag) [inside]
- e. **BASE**, BAKELITE, PLASTIC
- f. **CONDUCTIVE COATING** (ELECTRICAL) [outside]

ELECTRON GUNS

PARTS OF AN ELECTROSTATIC FOCUS ELECTRON GUN (in order of sequence):

(# 1) **FILAMENT** Wound tungsten coated element,(non conductive coating) much like an element in a light Bulb, to produce heat for the Cathode Coating, to initiate a process called “**THERMIONIC EMISSION**“. (causing **Electrons/Ions** to be generated by heat, when in a vacuum.

(# 2) **CATHODE CYLINDER** Hollow metal Electrode , containing a **nickel cap**, the top of which, contains coatings, which may emit **Electrons/Ions**. The Filament is placed inside, to supply the heat needed. **Note:** Under certain conditions, the **nickel cap** itself, may provide **electrons/Ions**

(# 3) **FIRST GRID [G1]**; controls the initial generated **Electron/Ion Stream**

(# 4) **SECOND GRID [G2]**; Accelerates the **beam** even faster.

(# 5) **SPLIT-ANODE**, where (2) structures were physically separated, but joined together with a wire {so as the (2) structures, may be considered as one and the same, voltage-wise}

NOTE: ANODE, in “**Electromagnetic**” **Focus Electron Guns**: Focusing was achieved by the use of a magnet, attached to, (part of), a spring arrangement, which circled the outside of the neck of the **CRT**, (like a ring on your finger). These types of guns, had a ONE-PIECE, **ANODE** structure.

(# 6) FOCUS RING A metallic ring, appearing,, but NOT connected to, AND residing between **(2)** structures, {see **(# 5)**above, {“split-anode”}. This type of gun was called an “**Electrostatic Focus Gun**”. This indicated that **focus** was achieved, automatically, as it was part of the Gun structure assembly. The necessary voltage, to create the required magnetic field, was provided by the circuitry of the T.V. set. See “**MAGNETIC FOCUS**” Electron Gun below,

(# 7) CROWN The very top of the **Gun-Anode** (cylinder), upon which **Spiders**, {see **(# 8)** and “**Getters**” **(# 9)** are attached}.

(# 8) SPIDERS (10) TO (12) pieces of metal, bendable, shaped like a Spider’s legs, emanating from the **Crown** (TOP) of the Anode, making contact with electrical coating, inside the **CRT**, (Glass Envelope).

NOTE: The **SPIDER’S** function was, to make contact with a conductive coating, (**Aquadag**), painted uniformly throughout the whole interior of the **CRT**. This was needed to carry the **High-Voltage** ,(10,000 to 25,000 volts), [dependent on Tube size], necessary for the tube , to function properly!

The **Aquadag**, a highly-conductive electricity coating, is painted in the entire inside of the bulb, (**NOT** over the phosphor screen). A metal button, (“**Anode Button**“), which is melted into the side of the Glass bulb, by the Glass manufacturer, is therefore common to both the inside **AND** the outside of the bulb.

That also , is painted over, such that, in effect, it provides an electrical path from the glass, to the button, to the Gun. When a heavy-duty wire, emanating from the High Voltage supply circuit is attached to it, that completes the electrical circuit, providing the High Voltage to the Electron gun part {**ALSO**}, called the “**ANODE**”, **(#5)**.

(# 9) “GETTER” A “**U-shaped**” element, with a bar across the top, attached to, and sitting upon the very top of the Anode. This bar contains an element called “**Barium**”. When the bar is heated up, from an external source of Radio-Frequency Waves {“**R F**”}, much like a Kitchen Microwave Oven), (except that that the type of **R F** equipment supplying that Energy, was meant specifically, to heat metal).

The **R F** activated the **Barium**, which caused it to absorb any gas remaining inside the **CRT**. It also left a deposit in the glass of the neck of the Tube, directly opposite of the **GETTER** location.

NOTE: A good indication of whether or **NOT** there was a **high** degree of vacuum, coupled with a **low** residual gaseous condition is, that when the **Barium** is activated, it has the ability to absorb any gasses. If **few** gasses are absorbed, the

inner side of the glass neck where the Getter is located, assumes a bright silvery look.

If there is a **poor** vacuum and/or a **high** gas content, then in that case, a **SMOKEY-black** coating appears, instead of, the **BRIGHT SILVERY EFFECT**. For whatever reason, when **OXYGEN/(air)**, enters the tube, the coating, (whether **SILVERY** or '**Smokey Black**'), the appearance on the glass neck becomes chalk **WHITE**.

If High Voltage is then presented to the **CRT** at that time, large sparks (and splats), are heard/seen bouncing, between the elements of the **Electron gun** and the **CRT** will **NOT** function. In fact, if left on long enough, damage to electrical circuitry will ensue.

(#10) "YOKE": NOT a connected part of the Electron Gun, but necessary for the Gun to be properly operated, is series of coils (connected as one piece), on the outside of the neck. When the **CRT** is inserted (neck-first), into the Yoke, the Yoke fits up against the bulb, (where the neck joins the bulb).

When different voltages are applied, they cause the Electron Stream to be directed left-to-right (Horizontally) and Up-and-down (Vertically). That function/ arrangement, is generally referred to as, "**SWEEP CIRCUITS**"

MAGNETIC FOCUS ELECTRON GUNS

NOTE: Among the first Television Tubes appearing in the U.S., were those of the "**Magnetic Focus**" type. The Electron Gun in those tubes, did **NOT** have a "**Split Anode**" [(# 5) of **PARTS**], as indicated hereinbefore, but a single gun structure, simply noted as the "**Anode**".

It also did **NOT** contain a "**Focus Ring**" (# 6) as an integral part of the Electron Gun. **Focusing** was achieved by other Coils, constructed, as an integral part, of the **YOKE** (#10).

An **ELECTRON** is a SINGLE PART of an atom. A (**MONOATOMIC ION**), is the simplest form of an Ion. It consists of One (**1**) **COMPLETE ATOM**, (usually containing many parts). Other Ions, may even be composed of, a bunch of Atoms . Those are called **POLYATOMIC IONS**).

It has been calculated, that **Polyatomic Ions** might weigh as much as { **844** } times as much, or more, than an Electron. Ions, with **NEGATIVE** charge, are called **ANIONS** whereas **POSITIVELY-CHARGED IONS** are called **CATIONS**.

Electrons are easily manipulated, (whereas **Ions** , which are many times heavier), are much harder to influence, with the same-strength magnetic field, of an **Ion-Trap**. The **Ion-Trap**, easily bends the Electron Stream, but because of the **ION's** much heavier mass, there is very little, if any, effect on the **Ions**, (whether Positive or Negative).

Therefore the **Ions**, when so concentrated, could be a very destructive energy force, particularly on the Phosphor coating. The Phosphor Coating was meant to display video information. **NOTE:** See the power of concentrated, uncontrolled Ions, later herein.

Later on, a thin coating of aluminum again allowed the **“Straight Gun”** to be used. There, the aluminum took the brunt of the impact by the **IONS**, accompanied by **Electrons**, in the **COMBINED Electron/ION Stream**. It went through the aluminum coating, and delivered the information so to **“DRAW”** the picture, which was signaled by the sending source.

The magnetic field, generated by the **“YOKE”**, WAS/IS powerful enough to control the **Ions**. (A **Yoke** is a piece of electronic part, through which the neck of the **CRT** is inserted. It contains a series of electrical coils, which generate magnetic fields. Their effects, reach into the vacuum. **THEY** control the movement, of the gun-generated, Electron Beam.

It can, by the appropriate signals, order the electron beam to go from **left-to-right** and/or **up-and-down** the phosphor screen, or any combination thereof. The **yoke** is a/k/a **“SWEEP CIRCUITS”**.

The **Electrons** generated, during the thermionic emission, also went along with the **IONS**. Despite the electrons light weight, they helped the screen to light up, (**fluoresce**), even brighter, for any given amount of electrons in the Stream.. (See **“ALUMINIZING”** later herein).

The **Electron/ION** pinpoint-stream, initially has the power to penetrate the aluminum layer, going forward, but **NOT** enough to bounce back out, in the opposite direction. Further, that Aluminum Shield, also causes all light to be directed/reflected, toward the viewer, making a far brighter picture, than that, with a phosphor-alone, **NON**-aluminum protected, **Bent-gun CRT**.

CATHODE COATING

This emitting of Electrons/Ions, are produced by a heating element, (much like a conventional **100-watt** light bulb), which is fitted into the hollow Cathode cylinder, directly below the flat, coated side, of the Cathode Cylinder. These coatings, (stimulated by the intense heat of the **Filament**, which is prox **{800 Degrees C }**,[**1472 Degrees F**], generated many **Electrons** and **Ions**.

Then, via instructions from the set-up, of the T.V., obeying directions from the Televising source, directed by G 1, the Cathode Coating to release varying amount of **Electrons**. This varying intensity of the combined **Electron/Ion Stream**, dictated whether the Phosphor would glow brighter, less brighter, or have **NO** brightness at all.

Generally there is a combination of (3) materials, containing many diverse Ions, which are deposited on the flat top-side of the round metallic cylinder, (CATHODE) which was to be the recipient of the heat, generated by the filament.

The **FIRST** Coating of the Triple-combination, was chosen because it liberated Electrons/ Ions very quickly, after the filament lights up, but, would only do so, for several years.

The **SECOND** coating, took a little longer to start providing the Electrons/Ions, but, it could continue to do so, for (5) to (10) years.

The **THIRD** coating, took longer yet to begin to supply the **Electrons/Ions**, but, could continue to do so for a long time. **NOTE:** Once the **Third** Coating, was heated long enough, it could then continue to provide enough **Electrons**, to present a good picture for (20) years or longer.

NOTE: That is why, as sets aged, they would take longer and longer to provide a good picture, but eventually worked pretty good.

The Cathode Coating , (physically, about 1/ 2 the diameter of a # 2 pencil-eraser and as thick as (3) sheets of 20 lb Paper), was deposited on the flat, outer top-surface of the Cathode Cylinder, (which contained the heating element "Filament") **NOTE:** Theoretically, that tiny amount of Cathode coating, could produce enough Electrons for the CRT, to last (100) years.

As disclosed earlier, in considering a Black and White Picture Tube, the more **Electrons** present in the pinpoint stream of electrons, the brighter the phosphor glowed in that one spot (PIXEL/Picture Element). The lesser amount of electrons which are contained in the Electron Stream (**less mass**), a less lighter, darker image , is portrayed.

This way, all shades of black-to-gray-to-white, could be portrayed. As color Television Tubes were starting to appear, the varying amount of Electrons, increased/decreased, the color of the impacted Phosphor, (**INTENSITY**).

DOUBLE-QUADRUPLE PRINCIPAL (LAW)

According to (1) of the laws of physics, entitled "**Double-Quadruple**" Principal, the Japanese **1,080** Horizontal-line system, (double the amount of Horizontal lines projected than that of the American **525** Line-system), provides a (4) times **BETTER** picture that of the U.S. **525**-line system.

Example: of "**Double-Quadruple** ". If a (1) inch hose, can pump (100) gallons of water per minute, then a (2) inch hose can pump, (400) gallons of water, **NOT** the (200) gallons per minute, that "**common sense**" would dictate. The **double-quadruple law** impacts many other common-day occurrences, perhaps unknown to Lay people and even most of the populace.

Another, MORE COMPLEX Example: A certain “Wind Generator” produces (1,000) Watts of electricity in a (7) mile an hour wind. However, if you increase the wind speed to 14 MPH, the same windmill will produce (4,000) watts of electricity.

Then if the original diameter of the Wind-Blades are (3) feet, and you increase the Wind-Blade diameter to (6) feet, you NOW produce 4,000 Watts of electricity in the 7 MPH wind. Again, if you do both upgrades at once, (double the wind speed, AND double the blade diameter), you now will produce (16,000) Watts of Electricity, from the (6) foot Wind-Blade, in the 14 MPH wind).

Most of the information herein relative to “Electron Guns” have reference to those “GUNS” used for presentation of Black & White Television. The following, is some extra information regarding “Electron Beam Color Guns”.

COLOR PICTURE TUBES

In a REGULAR Color CRT, there are (3) {Black and White} guns, physically arranged together in a triangular configuration, which are called the “Red Gun”, the “Blue Gun” and the “Green Gun”. However, they all produce Electrons, which are COLORLESS.

The Colors ascribed to the GUNS, are really for the sake of convenience and ease of discussion. The (3) phosphors, deposited on the face of the CRT, are in the form of minute dots, which are arranged in a triangular configuration.

The Electron-guns, likewise are situated in TRIANGULAR array, in the far end of the neck of the CRT. They are positioned such, that Electrons emanating from the “RED” gun could hit only Red-colored phosphor dots, but NOT Blue nor Green Phosphor Dots. This was because of an ingenious use of a “SHADOW MASK SCREEN” (much like a common window screen).

This Shadow Mask Screen was fixed, in place, a short distance in front of the color dots of Phosphor, {TRI-COLOR} SCREEN. It was located between the top of the Electron Gun and the Tri-color Screen. In turn, the “BLUE” Gun could only impact the Blue Phosphor Dots, (but NOT the Red, Nor the Green Dots).

Similarly the “GREEN” Gun Electron Stream could only impact Green Phosphor Dots, but like-wise, could NOT hit the Red, NOR the Blue Phosphor Dots.

Later advanced models Color CRTs, consisted of BANDS (strips) of the (3) colors (in vertical array) and the extremely fine portions of all (3) color Bands were bounded by dark Blue bands, in the Horizontal Axis. The guns in that case were situated in a straight line, NEXT to each other ...NOT ...in a triangular alignment.

The **(3)** Bands of TRI-Color, likewise achieved all Colors and thousands of variations as was possible, with the “**Tri-Color Dot**” Phosphor arrangement..

How Television is Provided Through the Electron Gun:

Typical voltages and/or applied voltages for general Television Tubes were as follows: {with **ALL** voltages **DC** positive, except where indicated} :

The Filament **6.3 V** AC @ **600 MA**;
Cathode **-5 V** ;
(G1) **10 to 30** volts ;
(G2) **250 to 400 V** ;
Focus Ring **0 to 300 V** ;
Anode/Spit-anode **8,000 V** to **20,000** Volts.

NOTE: Electron Guns, operating at higher than **20,000** Volts, required “**WARNING-LABELS**”, of **possible radiation side-effects**. The Warning Label recommendation was, that there should be at least **(3)** feet or more, between the viewer and the face of the Tube! As Tube sizes increased, so did the necessity for increased High (Anode) Voltages. Therefore, a proper Viewing-Distance Chart, was thereby developed.

This was not as bad as it sounds, because the **X-ray** radiation was bound by the **INVERSE SQUARE RULE** . That rule dictates, that as you **double** the distance **away**, from an **X-ray** source, radiation, in Roentgens, **decreases** by the Square of the Distance, in Centimeters.

The filament, at a meager **6.3** volts, A.C., drawing **600** milliamps of current, generates heat in the range of **800** degrees (**C**), [**1,472** degrees (**F**)], so as to cause the electrons and ions to be emitted in a cloud. Then, different voltages, presented by, and to, the gun shaped the electron/ion beam, focused it, and ultimately propelled it, as a pinpoint stream, into the Phosphor Screen.

Then by instructions from the transmitting signal, either to the Cathode or **G1**, it directed the resultant, focused electron-beam, to display a “**mirror image**” picture of the one being sent from the Televised source onto the phosphor screen, to be viewed.

The **Filament**, (also called a **Heater**), supplied the heat necessary to liberate Electrons/Ions from the **(3)** coatings. There was enough coating (**TECHNICALLY**, to supply Electrons/Ions for **(100)** years. Some **CRT's**, were found to be still working, (with an acceptable picture), after **(50)** years

SCREEN BURNS

Originally, (circa 1944), DUMONT used a magnetically-deflected, electronically-focused "STRAIGHT GUN". The Electron/Ion beam was sent directly to the screen. Unfortunately, it was found, after a period of (1) to (3) years, that the Straight Gun, which it used, produced a burn in the visible screen, which RESEMBLED the PATTERN, being broadcast by the T.V. Station. In 1947, television programming was broadcast, (in the N.Y./N.J metropolitan area), only (1) or (2) hours a day.

A little earlier, (in that time frame), at 5 P.M., Ch 5, Allen B. Dumont. (WABD), showed "HOWDY-DOODIE", (5) days a week. Since I was working the 4 P.M. to 12 Midnight, I ALWAYS watched that show, while working. HEY, there was NOTHING else to watch!

Having said that, most people I knew, NOT only watched HOWDY-DOODIE, but left their T V. lit up all day. Some even stared at the empty screen and/or the TEST PATTERN for hours at a time.. They were hoping to see whatever else MIGHT be broadcast, (NO TV GUIDE or newspaper schedule yet). Therefore the Test Signal, or the lighted screen (raster), was being bombarded/ burned incessantly, into the Phosphor Screen).

Come to think of it, was it good or bad advertising to see the WABD Signal (pattern) burned into your screen, while the set was NOT even turned on !

Worse yet, with T.V. being a novelty, people were NOT sure how to use the T.V., they always left their T.V. sets turned on (10) to (15) hours a day. So, even when there was NO station-identification signal being broadcast, they STILL left their T.V. sets turned ON. However, all of the propelling voltages, relative to the Electron stream, were still being performed, (albeit with NO video information), showing a fully-illuminated bright screen).

In those cases, after X amount of hours, in the alternative to having the WABD Test Pattern displayed, you had an un-interesting "Skull and Crossbones"-like effect, as the phosphor began to have that image etched onto itself. That would NEVER disappear, even when normal video information was only meant to be seen. That over time, became un-acceptably, ever-present image, on the Phosphor screen

The only remedy was to cut the CRT open, wash out that burned screen and cause a new screen to be deposited. However, some tubes, which were exposed to that constant Ion/ Electron bombardment for many years, ignored that distracting, ever-present occurrence. They continued to suffer that annoying effect, because, replacing the CRT was the most expensive part in the T.V. Set.

NOTE: Even when returning that burned-screen tube, was returned to a tube manufacturer for replacement, the Manufacturer attempting to reprocess, (REBUILD OR "RE-GUN") the CRT, found that even when removing the old

phosphor screen, such still revealed, that **“Skull and Crossbones”** or **“TEST-PATTERN”** effect.

That was because that **“picture”** of a **Skull and Crossbones** was etched/BURNED-INTO the glass itself, and the Bulb would thereby be useless. That is one of the reasons, we have **“SCREEN-SAVERS”** today. Eventually, with the advent of **“aluminizing”** (vaporizing aluminum onto the phosphor screen), **“Straight”** Electron Guns, **EVENTUALLY** became the ones of choice.

Note: Since the Television bulb **WAS** far the most expensive part of the T.V. Tube, many enterprising **“Re-Builders”**, later on, purchased that **“useless”** **CRT**, (even tho the **Skull and Crossbones** was **BURNT** into the Glass itself), for only a small fraction of the original Bulb cost.

It then underwent remedial action (involving acids), which were used to obliterate that defect, by **ETCHING**, uniformly, the entire inner face of the **CRT**. After that treatment, there was absolutely **NO** Skull and Crossbones defect visible. Of course, you now also needed a new Electron Gun and all the materials and work needed, to fabricate a new, working **CRT**.

This end result of this process came to be known as a **“Rebuilt Picture Tube”**. **NOT** only did it cost much less money, but in later years, it resulted in an upgraded Electron Gun, and, the use of newer, better, Phosphors. That actually produced a **SUPERIOR** picture, than that provided originally. That **Rebuilding** process, also conserved raw materials AND energy, at a price, more people could **AFFORD**.

“BENT” (on purpose) **ELECTRON GUNS** AND **ION TRAPS**

A very important Electron Gun UPGRADE, for the replacement Tube, was the **“Bent Gun”**, which allowed few, if any **IONS** to bombard the Phosphor Screen, (pre-aluminum-shielding days). The **“Straight-Gun”**, out of favor ... temporarily.

The **Bent Gun** was designed so that the **Electrons** and **Ions** which were generated, were separated. Then, the **Electrons** were gathered together, shaped to form an Electron Stream {**Electron Beam**}, accelerated, in the initial part of the electron gun, and propelled, by high voltages. These actions, caused the Electron stream, to impinge on the Phosphor Screen.

A device called an **“ION TRAP”**, allowed the stream to proceed to its assigned task. It was a spring-loaded magnet, which fit around the outside neck of the **CRT**, that when rotated/aligned properly, allowed only the **Electrons** to provide the received broadcast, video instructions. **NOTE:** As technology evolves the **“Straight-Gun”** will again be revived. (See later herein).

NOTE: That term **“Ion Trap”** is a **MISNOMER**. It should have been termed, (and sometimes **WAS** called), an **“ELECTRON BEAM BENDER”**, because it did **NOT** trap **IONS**, but it had that effect.

It allowed both **IONS** and **ELECTRONS**, to emanate from the Cathode coating in a straight line. But, because of the PURPOSELY-designed Electron Gun, MIS-ALIGNMENT, **NEITHER IONS**, nor **ELECTRONS COULD** impact the Phosphor Screen. When the combination **ION/Electrons** were first emitted ,and attempted to go through **G1** on its way to the Phosphor Screen, **They could ... NOT !**

The **Ion-Trap**, was of sufficient strength to, and **DID**, influence the Electrons, because their **MASS** was much, much, lighter {**1/844 th** lighter}, than that of the **IONS**. Therefore the stream of Electrons, **WAS** bent (re-aligned), so that **THEY WERE** allowed to transmit video information, onto the screen. **MOST IONS**, were **NOT**, and they were allowed to dissipate, harmlessly. (**EXCEPT**), SEE the **EXCEPTION**, later on herein.

EXPLANATION: Since the **Electrons** generated, contained an electrical charge (negative), they were influenced (bent) by the permanent magnetic field, generated by the **ION-Trap**. They were allowed to be collected, shaped, {focused}, propelled to impact the Phosphor Screen.

As long as the **Ion-Trap** was properly arranged/ positioned, on the neck of the **CRT**, it tremendously retarded, if **NOT**, stopped the screen **Ion-Burning**. Because the much **HEAVIER Ions**, whether Positive or Negative, (although most **IONS** derived the **(3)** chemical coatings, deposited on the Cathode, **WERE** negative), such was irrelevant.

That was because , **BOTH**, were **LESS**-effected, by the limited strength, of the **Ion-Trap** magnetic field. Hence **NEITHER** the positive **NOR** the negative Ions **COULD/DID-NOT**, impact the Phosphor Screen.

The **IONS** continued to rattle around in the electron gun structure, until they were finally dissipated and did **NOT** cause Screen burning. As a backhand proof of this, consider the following. **EXCEPTION:** In a **RARE CASE**, a mis-positioned **Ion-Trap**, (around the neck of the CRT), somehow, **WAS POSITIONED** (by A technician), such that it caused the **Ions**, **NOT** to be immediately dissipated.

Instead, **IONS**, un-accompanied by Electrons, concentrated in an un-purposeful mis-alignment of the Electron Gun, to **bombard** the **Gun-Anode**. The bombardment was of such intensity, such that it caused the anode, initially to glow, in an obvious red-hot appearance.

When the **Ion-Trap** was slowly rotated, the redness of the **anode** lessened in the original area, while it started to get red-hot in a new area. Whichever way the trap was rotated, saw a corresponding part of the Anode, to glow.

NO doubt, that something, generated in the Tube, was the cause. Since **IONS** were **NOT** effected by the weak magnetic field, generated by the **ION-Trap**, (which easily influences the Electrons), the **IONS WERE** responsible..

The **mis-directed** Electron Stream, controlled by the re-positioning of the **ION-Trap**, when allowed to stay in (1) position for longer than an hour, **EVENTUALLY**, caused a circular hole to be **BLASTED** into the anode part of the Electron Gun, (about the size of half a #2 Pencil eraser). Coincidence ? About the actual size of the Cathode Coating.

NOTE: JUST LIKE BUCK ROGERS OR FLASH GORDON, A HAND-CARRIED PISTOL-LIKE WEAPON, THEY CALLED A “**BLASTER**”, or a **RAY-GUN** ? Right this second, this is a valuable tool, weapon, for use on the **SPACE STATION**, and wherever a Vacuum exists (natural or man-made). That “**ION TRAP**” magnet system, was **NO** longer being used, (circa **1960**).

Thus, it seems that even **IONS** and/or **Electrons**, **DO** have some weight {trillionths of a gram ?} , { **28.375** Grams to the ounce, (**454** grams to the lb)}. But, traveling in the vacuum, in the **CRT**, at/or near the speed of light, the Electron stream, (which built up the “**KINETIC ENERGY**”), impacted the T.V. Phosphor screen.

“**KINETIC ENERGY**”, is the force saved up, by the energy put in to any particle, which was necessary, to propel that particle. See **Einstein** below.

The impact of the Electrons, causes **TINY PARTICLES** of phosphor to fluoresce or light-up, according to instructions from the sending source, thru the Electron Gun. Even though the **Electrons** are virtually weightless, according to **MR. Hermann MINKOWSKI**, {one of **EINSTEIN'S** Professors}, rightly suggested that, “**SPEED INCREASES MASS**”. He never taught or discussed, whether or **NOT Electrons** had weight. **They DO!**

Later on, **EINSTEIN HIMSELF, TAUGHT** that, any object, attaining near the Speed of Light (**186,300** Miles per second), can have its Mass {weight}, multiplied by **200** times or more. Since ,the Electron Beam, proceeds at, or near, the speed of light, the impact, causes the selected impacted particles of phosphor to light up, {fluoresce}, momentarily.

That effect, (on a particular particle of Phosphor), was later defined as a. “**PIXEL**” [**Picture Element**].

Then, when the Electron Beam moved on to the next Phosphor particle, the Phosphor light slowly died out, [**“DECAYED”**]. **NOTE:** The smaller the diameter of the projected Electron Stream, the smaller amount of Phosphor particles may be impacted. Thus, the smaller diameter Electron Beam (spot), the better it is able to produce a finer, **MORE** lifelike, picture. This is characterized as, “**DEFINITION**”.

HDTV achieves excellent **Definition** because of certain circuitry. It provides information on **1,080** Horizontal lines, instead of **525** lines. This means (**4**) times as much information is able to be displayed, than the **525** system, as dictated by the “**DOUBLE-QUADRUPLE LAW**”.

NOTE: The combined mass of **Electrons/Ions**, propelled at such a velocity, may easily penetrate the aluminum, impinge upon and light up, the phosphor particles. However they do **NOT** contain enough energy, to reverse course and re-penetrate back, the Aluminum core, away from the Electron gun.

Additionally, the Aluminum cover, which is bright and shiny, then functions as a reflector. Therefore, most **ALL** of (**100 %**), of the available light-energy, is directed toward the viewer.

PHOSPHORS

“Electro-luminescent” materials, deposited on the inner face of CRT’s, when impacted by energetic charges, causes them to **“FLUORESCENCE”**. When struck by the Electron/Ion Stream, they **“GLOW”** brightly and then start to lose energy and then the glow **FADES** out. That occurrence, in effect, is characterized by the word **“PERSISTENCE”**.

The amount of time it takes **PERSISTENCE** to occur/be measured, is known as **“DECAY”** time. Phosphors come in different **DECAY** times, which depend on the ultimate use, for which the CRT will be used, {Special Purpose Tubes}). The Phosphors come in the following **Persistence** ranges:

Extremely Short; Ultra Short; Very Short; Short; Medium Short; Medium; Medium Long; and Long.

“DECAY” TIME”

Ascribed, as the period of time, (in **Milliseconds**), it takes the Phosphor to LOSE brightness, from **(1) Foot Candle**, to less than **(1) %** of that amount, for a Pixel to return from its excited (brightest)state, to little, or **NO** brightness.

Example:: For a **Radar Tube**, you want a phosphor with a long persistence. You didn’t want the blips to disappear, or blink on and off, (unless the program called on it, to do so).

For a Child’s Arcade-like Game, you want a phosphor with an extremely short persistence, (much like a **“REFRESH RATE” ABILITY**). This is to prevent **“BLEEDING”** {Colors mixing into the edge(s)of other colors} , thus the blurring of information, when it is presented at high speed.

This is because, the more intricate (life-like), pictures of people are portrayed, in an action program, (when calling for extremely fast action), demands that the Phosphor particles dim very quickly. If they do **NOT** dim fast enough, the brightness of **(1) Pixel**, mixes in, with the excitation (lighting), of another.

NOTE: Phosphors, also come in different tints/colors. The combination generally used for a Black & White Picture Tubes is a **“P4”** Phosphor. P4, has a **Medium Persistence**, with a **Blue/White tint**. Color Tubes employ **“P 31”** Phosphors, with **Medium Persistence** also. For photographic uses, certain Special Purpose, Black & White **CRT’s**, used a **“P 11”** Phosphor.

That was because the **Greenish Tint**, was better than the Tint of the **P 4** Phosphor, (more **Blue**). For filming, (with a Motion Picture Film Camera), **DIRECTLY** from the face of the **CRT**... (pre-**VCR/DVD** time), **P 11** was preferred..

SWEEP CIRCUITS

“Sweep” circuits, provided by an external device surrounding the neck, are responsible for **“DEFLECTION”**. This involves moving the Electron Stream from Left to Right and from the top to the bottom., which presents the picture. In the American Version (pre **H DT V**), **525** lines of video information, per second, is produced onto the screen. (more later).

In certain tubes, such as **Oscilloscope tubes**, **DEFLECTION**, (“sweeps”), was created by electrodes, attached to the Electron Gun itself (internally). That type of Gun was known as an **“Electrostatic Deflection Type”**. It also contained Electrostatic Focus capability, built in as part of the Gun, (as hereinbefore discussed).

INTERLACED SCANNING

Involves the use of **525** HORIZONTAL LINES OF INFORMATION. The American Television system was based on the **SWEEP** Circuits providing the **525** lines of Horizontal information, via a system called **“INTER-LACED scanning”**, (weaving together in an orderly fashion of all **odd** number **“fields”**, with all **even** number **fields**.

By repeating each frame twice, it was brought into sync with **60** Hertz (Cycle), Alternating Current. It was done, primarily, to cut down on **“flickering”**, as was prevalent, in the early days of moving pictures.

NOTE: That, also created a problem with European inter-mixing of television, because the European A.C. was put out at **50** cycles per second. That also created a problem This was controlled by the Horizontal frequency of **16,750** Cycles (now Hertz), per second, which drew pictures, based on the following procedure:

First, a field of **262 1/2** **ODD** lines of information were transmitted/received. Then, the field of **262 1/2** **EVEN** lines, of information had the same thing done. Thereby, the **Even** and the **Odd** numbered fields, were then joined together and called a **FRAME** . Each frame was repeated twice. Then the **(60)** Frames were broadcast second, making a total of **(60)** Frames per second., with the combined frames.

(60) frames a second corresponded with **(60)** Cycle Alternating Current, which at that time, showed that such actions would prevent/reduce flickering effects. This happens so rapidly, that combined with the **“RETENTIVITY”** of the phosphor, (to hold and slowly reduce the light generated by the high-velocity impact of the concentrated focused pinpoint **“Electron beam”**, usually called **DECAY TIME**). It helps fools the eyes into

seeing a complete image ,(**“SNAPSHOT”**), thus producing a full completed picture, in **“real time”**.

NOTE: COMPUTER uses, favor **“PROGRESSIVE SCANNING”**, (transmitting of information in sequential form. That scanning method scans (lines 1, 2, 3, 4, 5, 6 etc.. in order), as opposed to **“Interlaced”** scanning, and is also projected at **(60)** Frames/second.

ELECTRON GUN

An Electron Gun, an early upgrade of the Straight gun, known as a **“BENT GUN”** type, has electro-magnetic focusing provided externally, by a **“focus ring”** (encircling the glass neck and an integral part of the **YOKE**).

A **YOKE** was a one-piece unit, composed of coils of copper wire, which generated magnetic fields, which received instruction from the sending information. They, were meant to dictate and control, where the Electron Stream was to be sent This (1) piece unit was fit around the neck of the CRT, up to the bulb proper, (like that of a yoke on oxen).

Early gun designs, (Bent-guns), were structured, so as to be able to separate Electrons from Ions. They generated/liberated both, from the **“Cathode coating”**, (generally a combination of Calcium/Barium/Strontium or Cesium Oxides).

Imagine the Electron Gun, analogous with that, of the operation of an automobile.

1. **Turn on the filament** (Start the Engine)
2. **Apply 10 Volts** of positive voltage to G 1 (Put Car in FIRST gear & start moving)
3. **Apply 300 Volts**, positive to the 2nd Grid (Put Car in Second gear & accelerate)
4. **Apply necessary voltage** to achieve Focus (Head for the proper destination)
5. **Apply 12,000 Volts** to the anode (Floor Accelerator, achieve top (Speed))
6. **Smash Electrons** into Phosphor coating **WHOOPS! (AVOID, at all costs, smashing into anything)**

MANEUVERING, SHAPING, ELECTRON STREAM (BEAM), AND

“DRAWING“ A PICTURE.

This information applies to the “**bent-gun**”, Electro-magnetically focused GUN. Picture the round-shaped Cathode coating, releasing **Electrons/Ions** in a “**cloud**”.

Then by applied voltage differentials, between the Cathode (negative charge) and **G 1** (Positive charge), the Electron/Ion cloud, becomes a “**STREAM**”(a lot of Electrons in a bunch, also described as a RAY, {**CATHODE -RAY** }) and are accelerated thru the round hole (aperture) of the **CONTROL GRID (G 1)**.

FOCUS ACHIEVEMENT

Now comes the **hard part to envision**:

First, let's get rid of the **Ions**. A “**Bent-gun**” is so aligned, that any **Ions AND Electrons** can **NOT** impact the Phosphor Coating, because of its purposeful mis-alignment.

An externally-mounted permanent magnet, (called an **ION-TRAP**), is spring loaded, around the outside of the neck of the **CRT**. This magnet may be moved forward or backward, as well as being able to be rotated,(by a Technician), in a **360 Degree** alignment, around the neck of the **CRT**.

With the T.V. turned on and producing all necessary voltages, proper alignment influences the stream of **ELECTRONS** to be “**bent**”, and successfully, go through the **G 1** aperture. through the **G 2** aperture. Electrons **ARE easily** influenced by the strength produced by the Trap's magnetic field.

Almost all the **IONS** generated/released by the Cathode Coating are **NOT** able to be bent by the weak magnetic field, generated by the **ION-Trap**. That is because the **IONS** are **844** times or more , more massive (heavier) than the Electrons. Therefore the **IONS** cannot access the **G 2** aperture (hence, the name “**ION-TRAP**”).

“CROSSOVER” POINTS: NEED & EXPLANATION

Here comes the tricky part: Since the actual Cathode coating deposition, has a much larger diameter than the **G1** aperture, Electrons emitted from the **LEFT** side of the Cathode, have to move **Up and In**, where eventually they will “**Criss-Cross**” each other.

The **Electrons** emitted from the **LEFT** side of the Cathode Coating will head toward the **RIGHT** side of the **G2** aperture, while the Electrons emitted from the **RIGHT** side of the Cathode Coating, will head to the **LEFT** side of the **G 2** aperture.

Yet again, Electrons from the **TOP-SIDE** of the Cathode Coating, head to the **BOTTOM-SIDE** of **G 2**. Similarly, Electrons from the **BOTTOM-SIDE** of the Cathode head toward the **TOP-SIDE** of the **G2** aperture.

In fact, **Electrons** from every point, (in a **360 Degree Circle**),each and **ALL**, head for **THEIR** opposite location, in an ever-narrowing funnel-like shape, until it reaches a very **FINE** point, (**DOT**).

However , it does **NOT** stay in that fine point. The **CROSSING MOMENTUM** continues, so that the **Electron Stream**, starts to form a new funnel arrangement. At that transition point, when the very fine Dot starts its expansion, such is called the **“CROSS-OVER POINT”**), and again, it starts to expand, (funnel-like).

As the **Electrons** keep on heading, toward the Phosphor Screen,(picture), with the new momentum of expanding ever larger, it enters the influence of the **Focus-**generated magnetic field. Then, the **Electron Stream** is then subjected/forced, to again to begin to attempt another **“Cross-over”**, which ultimately results in the focus desired.

The **Focus-Coil** for use with a **BENT-GUN** is mounted on the outside of the neck, immediately in front of, and part of the **“YOKE”** assembly. The **YOKE** sees/controls the ENTIRE COLLECTION OF **ELECTRONS (STREAM)**, and by various voltage signals (creating varying strength magnetic fields, move the **Electron Stream, Left or Right; Up or Down**, as only **(1)** complete part, (**“YOKE”**, defined earlier, herein).

At that time, the funnel, fully opened, starts to narrow again, attempting yet again, to achieve a **CROSSOVER** somewhere in the Bulb proper. Under the influence of the **Focus-oil’s** strong magnetic field, the Electron Stream is heading to impact the Phosphor, while also trying to achieve a Cross-over.

If the **Focus Coil** voltage is too **LITTLE**, the Electron Stream wants to **CROSSOVER**, far **BEYOND** where the Phosphor coating is (technically, beyond the outside of the **CRT**). If too **MUCH** voltage is applied to the **Focus Coil**, it creates a stronger magnetic field, and **ACHIEVES CROSSOVER**, far in **FRONT** of the Phosphor Screen.

PROPER CROSSOVER POINT ACHIEVED, IDEAL FOCUSING OF THE ELECTRON BEAM:

But, with the proper **Focus** Voltage applied, the pinpoint Dot of the **Electron Stream**, lands **EXACTLY** at the Phosphor Particle **DEPOSITION** on the inner face of the Bulb . Therefore the **Electron Stream** is **STOPPED** from effecting the Crossover, (**PERFECT FOCUS**). The smallest pinpoint **Electron Stream** impacting exactly at the Phosphor particles. That is exactly what is **NEEDED** to effect maximum sharpness/clarity, of the transmitted video material.

Too much/too little **Focus** voltage, and the **Electron Stream** does **NOT** impact the Phosphor particle(s), exactly were they are supposed to, therefore showing a **“FUZZY” (OUT OF FOCUS)** picture. But, by fine-tuning the **Focus** Voltage, we make the **Electron Stream** attempt the **“CROSSOVER”**, directly at the Phosphor coating, thereby allowing all the electrons to go to their broadcasted (signal) positions.

This creates a **SHARP** in-focus image, (**UNLESS**) there are too many **GAS** Molecules present inside the **CRT**. If the **Electron Stream** collides with too many **GAS** molecules, even when the **Electron Stream** is perfectly effected, the striking of too many Gas molecules, **WILL** deflect the **Electron Stream**, so as to present a “**Blurry**” picture, **DESPITE** the **Focus Coil’s** perfect functioning.

HIGH-DEFINITION TELEVISION, JAPANESE STYLE:

High Definition Television, (**HDTV**), is a **1,080** horizontal lines **SYSTEM**, promoted by the Japanese, which is becoming very popular in the U.S. (circa **2007**). Unknown by the Television Industry, a **2,000** line System, Ultra High Definition (**UHD**), was actually **INVENTED**, constructed and used in **1956**, by the author hereof, Carmine A. Cifaldi,

At a request from a Medical Facility in **Philadelphia**, the author hand-crafted that **Electron Gun** and installed it, (in a Special-purpose **CRT**), with a special high decay-speed , green-tinted Phosphor,.

ULTRA HIGH DEFINITION SYSTEM (UHD) 2,000-LINE SYSTEM

The author’s “**UHD**” **Electron Gun**, was used in conjunction with a high-quality, Motion Picture Camera, using High-speed film, to photograph directly from the face of the **CRT**, an actual/live, laparoscopic gallbladder removal operation. Unfortunately, that **Electron Gun/2,000-line** system was **NOT** patented, because the Television Industry was **NOT** able **NOR** ready to use it, (mainly because of “Bandwidth” constrictions).

The **Bandwidth** spoken about here refers to Space allocated for transmission of a signal over the air. It should **NOT** be confused with **Bandwidth**, relative to the amount of room/capacity, which a Televising System has available to project a signal. In any given system/network, (video, as well as audio), (such as used with Cable resources), needs plenty of storage-capability.

HDTV is routinely credited today, as being of Japanese origin. Whatever the case, **HDTV**, when coupled with “Flat Panel” devices, may now produce a picture, rivaling the finest photographs, (**circa 2000**).

TECHNICALLY, HOW “UHD” WAS ACCOMPLISHED, IN 1956:

Note: Now, **UHD**, the **2,000-line** system, can produce a **(4)** times better picture, than the **1,080** Japanese system. Therefore a **(16)** times better picture than the **(525)**-line system, can be projected, (as dictated by the “**Double-Quadruple Law**”).

Further, **NO** extra equipment is needed by the home viewer. The **2000-line** capability was achieved as that similar to the **1,080** System by the appropriate circuitry, plus using the “**INVERSE**” of the **Double-quadruple**

Law, in the following way: **EXPLANATION**, as (below written, of how the **Double-Quadruple Law**, dictated the final result.

Normally, the aperture (hole) in Grid One (**G 1**), is approximately (**40,000ths**) of an inch in diameter. Using an Electron Gun containing a **G 1** aperture of (**20,000ths**) of an inch, (**1/2** the diameter of the normal), has decreased the round circular shape of the electron beam, (**4**) times).

EXAMPLE OF “INVERSE DOUBLE-QUADRUPLE PRINCIPLE”, (LAW):

A (**1**) inch diameter Electron-beam, is now shrunk to a **1/4”** diameter beam. Therefore, it may create **MORE** Horizontal lines of information, because of its ability to impact ever-smaller molecules of phosphor. The **2,000**-line system may now show, much finer detail.

That is exactly what Medical people wanted, plus an easier-to-photograph, (in Black & White, {pre-color days}), a **Green-tinted (Phosphor) Screen**, with which to photograph the operation, directly from the face of the **CRT**. (That was pre **VCR/DVD** time).

Full implementation of either the **1,080** or **2,000** line system, is the fact, that most T.V. sets in use in the **1970’s** could **NOT** use those signals, (as mandated by the FCC).

Therefore they were **NOT** allowed to be Broadcast over the air-waves because of limited Broadcasting (AIR) Bandwidth space. **EXCEPT**, now we have wide-spread use of Cable, Satellites and **“STREAMING”**, **ALL** of which have overcome the problem.

STREAMING

Streaming video is a sequence of “moving images”, that are sent in compressed form, and displayed by the viewer, as they are arrived.

The use of **“STREAMING”**, encoding of **“DIGITAL SIGNALS”**, basically sending instructional signals in a straight line array, **INSTEAD** of using the Frequency Modulation or Amplitude Modulation formats. Both of those methods, require large areas of the AIR-Broadcast Bandwidth.

Now allowing **PREVIOUSLY** un-allowed Broadcasting signals to be sent through the Air, as well as through Co-axial Cable, or Fiber-optic glass-pipes, it is routine.. Satellite-provided signals, **“Streamed”**, are also allowed to beam information, in that manner. Therefore, Television signals received from Satellites, (in **“Geo-synchronous”** orbit), with associated equipment, is still a viable use of transmission.

“Geo-synchronous”, basically, a satellite circling earth at **17,000** MPH, appears to stay in the same place, relative to any observer. That is because at a certain altitude, it matches the apparent speed of the earth’s rotation, (which is about **1,080** MPH). How come the big difference ? The **satellite** is circling in a larger diameter, therefore it has a greater distance to travel !

Older sets were equipped with **Conversion boxes**, to receive **ALL** methods of transmission directly at the Television sets in the home. Over-the-air, Station Broadcasting, as still practiced by **RADIO**, is rarely used (circa **1980's**). The **NEGATIVE** side, for that type of transmission is, that inclement weather conditions may interrupt signal receipt at any time. Further, the receiving **DISH**, must **NOT** become mis-aligned, resulting in total loss of signal.

Signals may also be interrupted, when there is **NO** obvious sign of localized inclement weather, because several miles away, they are receiving heavy rain squalls. Also, when the Electricity fails in your area, there will be **NO** signals received, either.

On the **POSITIVE** side, the signals may be received where there are **NO** Cable lines. With certain equipment and/or batteries, the signals may **EVEN** be received/used, where **NO** electricity, is available from traditional sources.

HOW THE TELEVISION PICTURE TUBE (CRT) IS MANUFACTURED:

(21) Steps **#1A** A clear, clean Television Bulb, (as manufactured by Corning Glass), whose neck is placed over a standpipe, is connected to a fluid (water-like) pumping station which re-circulates a mild acid (Bi-fluoride or Caustic Soda), for 30 seconds. Then it is rinsed with fresh, clean Tap-water (**10 to 15** seconds).

SCREENING of CRT (DEPOSITION OF PHOSPHOR COATING).

#1B The Bulb, is then placed and **CLAMPED** onto an hydraulically-operated **"TILT TABLE"**, (which will be able to rotate smoothly, in a **270** degree arc). This will **NOT** cause ripples when pouring out, the **SLURRY**, of **PHOSPHOR**, and **DISTILLED/DE-IONIZED** water.

The Slurry which is to be poured in, which will be introduced into the Tubes, in the next step of manufacture. This apparatus, (**Tilt Table**), can rotate **FROM** the Horizontal upright Tube (neck up) position, **TO** the Horizontal reverse or neck-down position.

#1C (**1**) to (**3**) gallons, (depending on size), of pure **de-ionized** or **distilled** water, containing a **1/10** th % Barium Acetate reagent, is introduced into the bulb. Next, a water/phosphor slurry, is introduced, from a shower-like dispensing piece of hand-held equipment, called a **"THISTLE TUBE"**.

NOTE: Because of the expense of purchasing **distilled** water, many manufacturers of T.V. Tubes, bought their own **DE-IONIZER** machines. Some units contained (**4**) [COLUMNS (Beds)]. with (**2**) columns of **ANION** Resins and (**2**) columns of **CATION** Resins, arrayed , in a sequential arrangement.

NOTE: De-ionized water is fed through a combination of **ROCK/SAND/ACTIVATED-CHARCOAL** filters, followed by a Stainless Steel (S.S.) Container

with an interior element, also of Stainless Steel. This S.S. Filter could filter out particles as small as (1) Micron, and if used with FILTER AID, could filter out particles as small as, (1/10), of a micron. A micron is a unit of measurement, which is extremely, (microscopically small). It is (1) millionth of a meter whereas a meter is 39.37 inches.

DISTILLED WATER, (much more expensive), **DID NOT** have to go through the filtering procedure. Otherwise, De-ionized Water treated this way, was indistinguishable from **DISTILLED Water**, (at about 10 % of the cost). Neither **Distilled Water** **NOR De-ionized water** contain any metals. **De-ionized water** may contain viruses, certain other organic materials, while Distilled water does **NOT**.

NOTE: During certain warm, dry, earthly temperature periods, the organics in the **De-ionized** water, can prevent screening. The organic residues contained in the water, have the ability to develop an oily bubble around itself, which, (unlike air bubbles, which are easy to burst), are very tenacious, and are very hard to burst.

When a tube is decanted on the **Tilt Table**, tubes, containing these bubbles, (usually in every tube), **drag**-lines down the screen appear, as the water is exiting the tube. That presents an unacceptable screen, and must be re-washed and re-screened..

NOTE: A solution to that problem, is to draw a partial vacuum on the tube, just prior to de-canting. That **DOES** break those bubbles. The organisms themselves are too small and too light to drag lines in the phosphor.

The amount of phosphor slurry, for each tube proportioned therein, ranges from approx. (5) to (15) Grams of Phosphor, (28 1/3 Grams to the Ounce), relative to the size of the Bulb. The slurry, relative to tube size, could contain anywhere between (300) and (700) Cubic Centimeters (C C 's).

The Thistle Tube, funnel-like on top, also contains a (18) inch long, hollow, plastic tube, that has a 1/2" INNER diameter. At the bottom end of the tube is a **THIMBLE-like cap**, which has (15) or (20) holes, uniformly distributed on all sides, with a series of (8) holes, angled outward, in (North; East; South; & West directions), in the rounded convex bottom of the **thimble**.

The Phosphor slurry, is poured into the top of the funnel, drops down the long plastic pipe and exits the **Thimble-like** end, which thereby disperses the water, much like a shower head. While the Slurry is pouring out, the entire **Thistle-tube** is rotated, continually, 360 degrees, until emptied. This way, you may be assured, that the phosphor is uniformly dispersed, into the water.

The outer stream of slurry, should be directed at a point just before where the top of the water level meets the wall of the Bulb. The phosphor is then allowed, undisturbed, to "**SETTLE**", deposit uniformly, on the glass. When

settling is completed, it leaves an almost perfectly clear solution, with the Phosphor laying down on the inner face of the Tube. The Settling time is **(10)** minutes.

Then the **TILT table** is slowly gently tilted, (Hydraulically “DECANTED”), so that the water pours out completely, (taking care **NOT** to encourage a **GURGLE**, { air attempting to enter into the Bulb, while water is attempting to leave the Bulb }

If you allow water to pour out and leave enough room for air to come in to replace the water pouring out, the newly deposited Phosphor will **NOT** be unduly disturbed. Total elapsed Phosphor-coating time, including “settling” time , is about **(13)** minutes, for a Table-Load of **(8)** to **(10)** Bulbs.

#2 When **ALL** water has left the Bulb , leaving it completely empty, unclamp the Tube from the table (when the neck is pointed to the ground and do **NOT** allow any residual water to flow back onto the screen. Place the tube (neck first), over a thin Standpipe which is connected to a mild, slow-speed, warm-air dryer (much like a hair dryer), which will dry the wet screen (including the interior of the bulb).

The top of that pipe should be closed-off, so as to **NOT** blow air, directly on the freshly-deposited phosphor. But the Pipe, **WILL** have holes emanating from all around the sides of the pipe, near the top. The Screen-dry time takes about **(10)** Minutes.

3 Remove the Bulb from the Dryer, gently place the bulb, is on its side, with the opening in the neck, facing you). Re-wet the phosphor screen, using a **3/8** th or **1/2**” curved, inner-diameter, polyethylene tube (approx **10**“ long), with a solution containing distilled/de-ionized water, which also contains **3 %** portion of Potassium Silicate , (a chemical-binding agent).

Do **NOT** unduly disturb the phosphor coating. **NOTE:** Do **NOT** use tap water, as this will absolutely contaminate (“poison”) the screen. This contamination will not be readily discernable in the initial stages of manufacture, but after baking, (a later step), you will see round colored spots appearing all over the screen, (which would be unacceptable to the viewer).

NOTE: In a later step of manufacture, called “**BAKING**”, an Ultra Violet light shining on the tube face, (in broad daylight, would make the screen light up) {fluoresce}, revealed this contamination. It would be as if, the Phosphor Screen were being impacted by the Electron Beam while under vacuum.

Green spots , (like measles), would indicate **COPPER** contamination, **Blue-colored spots**, will indicate **BRASS** contamination and **PURPLE COLORED SPOTS**, indicates **IRON** contamination..

If the bulb is allowed to continue to completion, eventually, when video information is displayed, **Green** and **Blue** spots or **Purple** spots, (in stationary positions), in **ALL** White display scenes, would make the picture(s) unacceptable, as was the old Straight-Gun, non aluminized, Black & White Dumont Television Tubes, (circa **1945**).

PREPARATION FOR ALUMINIZING PROCESS

APPLY A LACQUER COATING TO PROTECT THE PHOSPHOR FROM ALUMINIZING

Introduce Water mixed with a **20 %** amount of a fine polymer lacquer gently, onto the same Screen, as you did on the **TILT TABLE**. Place the Screen-Wet Bulb on a spinning machine which causes the solution to spread evenly (by Centrifugal Force), over the entire screen area. Elapsed time **(3)** minutes.

#4 Since we do **NOT** want residual lacquer to be positioned over the entire inside of the Bulb (we really do **NOT** want it on the Screen either), but it serves an extremely important function, {which will be revealed later} Place the neck of **CRT** around a flexible plastic pipe on another spinning machine, which dispenses water in a fine non-splashing stream of water.

Wash out (trim-away) all lacquer and water from the interior of the bulb (while spinning). **EXCEPT** THE phosphor Screen. Start washing the interior of the bulb, (while revolving), starting at about **(3)** inches from the top of the Bulb, from where the Phosphor Screen lies. Elapsed time about **(3)** minutes.

NOTE : This lacquer will be baked out in a later operation, but for now, will protect the Phosphor Screen from the Aluminizing application to be performed next.

If the lacquer is **NOT** removed properly, then in that case, when the CRT is functioning in a normal T.V. set, it will be reduced to a Gas, where its molecules will interfere with Electron Beam and cause a **“Fuzzy”** of **“Blurry”** picture, when in use.

More importantly, the Gas molecules will attack the Cathode Coating, by depositing a **BLACK**, non-Electron-releasing substance, which would interfere with and dramatically shorten, the life of the Cathode Coating, hence the Tube.

RE-ACTIVATION/REJUVENATION OF “DEAD” PICTURE TUBES

Some more: Certain erudite Engineers, developed a device, which could apparently re-activate the electron-creating Cathode Coating, by removing the black layer of substance, from its surface. The coating underneath was still able to produce Electrons, but the black surface coating could **NOT** be penetrated. They called this process **“re-activation”**-**“rejuvenation”** of the **CRT**.

It **REALLY WORKED** and could restore, **IMMEDIATELY**, the presentation of the picture from a low light output picture to a beautiful high light (normal) picture. In fact some tubes were even better than new, because there was always a slight layer of black deposition from other sources. The terrific positive end-result, was because of the way the **reactivation** device worked.

SECRET PROCEDURE EXPLAINED

Here the secret is revealed: A High Voltage, probably as high as **1,000** volts, was placed for **(1)** fraction of a second only, between the cathode and **G1** (when normally they are **NOT** interconnected). In fact they had to be separate, for the T.V. Tube/Set to function properly).

That High-Voltage created an ARC, which blasted the unwanted coating away, creating a lot of heat to the cathode cylinder. Because that process created a great amount of heat, the resultant was observed immediately. Remember, electrons are generated from the Cathode Coating, by the heat (**800 C 1472 F**), supplied by the filament.

5 Put the mostly lacquer-free Bulb back on the dryer and dry everything, once again. Elapsed time about **(10)** minutes.

APPLY HIGHLY-CONDUCTIVE (AQUADAG) COATING TO INSIDE OF BULB

6 Place the screened tube on a piece of equipment, which may be rotated, that has a tube holder, and is able to spin the Bulb as slow or as fast as you desire. Using a tiny brush (about **(2)** inches in length and about **3/8ths** “ wide, containing bristles about **1/2**“ long, apply **(paint)**, a black conductive coating, (**AQUADAG/Dixonac**), to the entire inside of the bulb.

NOTE: Make sure that the coating completely coats the glass, including the **Anode button**, (the metal button fused into the bulb), because it is common to the **INSIDE** of the tube. It also provides an electrical path, from the **OUTSIDE**, the **CRT**, for High Voltage to come **INTO**, the Electron Gun).

The **Aquadag** is painted with hand brush-applying strokes, (throughout the entire bulb), and/or by spinning the bulb, holding the brush still. Then the spinning machine action, causes the paint to be spread, uniformly. **NOTE:** Take care, that the **Aquadag** does **NOT** splash/impact onto the Phosphor Screen. Elapsed time to achieve painting about, **(3)** minutes

#7 Place the Bulb neck, around another Screen Dryer to dry the conductive coating painting . Time to dry Dixonac coating about **(7)** minutes.

ALUMINIZING PROCESS

8 Remove the tube from the dryer. Place the neck, around an electrode, protruding upward in an Aluminizing Machine, up to the “Yoke” area, where the seal is made, so that the Tube may be put under Vacuum. The Electrode contains a (Tungsten), heavy-duty-use cycle, Coil.

Place a pre-measured piece (slug) of aluminum (about **3/8** ths long by a **1/4** of an inch thick) in the Coil, which is in a horizontal alignment. Starting the Aluminizing Machine up, a Vacuum Pump, (part of the machine/operation), draws a vacuum on the enclosed **CRT**.

When the Vacuum is completed, on command, the Tungsten coil (at about **(12)** Volts, dispensing about **45 to 60** Amps of electricity, causes the aluminum slug (pellet), to slowly melt into a liquid ball, and then to finally disburse (like a steam cloud), until the whole slug of Aluminum has been evaporated, from the Coil, (called “**ALUMINIZING**” OR “**SPUTTERING**”.

The resultant cloud of Aluminum particles would then have been attached, uniformly, over the entire inside of the Bulb (including the Phosphor Screen AND the Aquadag conductive coating AND the Anode button). Elapsed time about **(20)** Minutes.

BAKING THE TUBE, TO DRIVE OUT ADSORBED GASSES

9 Place the Aluminized tube in a High-Temperature Heating Oven and bake at **410** Degrees **C**. {slightly higher than the regular processing Temperature of **400 C** }, which will be done later, in the evacuating “**PUMPING**” {vacuum processing procedure} .

Essentially, this baking cycle will thoroughly dry **ALL** material put into the bulb for processing, and most importantly, vaporize, to the atmosphere, the Lacquer put in, (which also covered the Phosphor Screen), via a previous operation.

When that is completed, there is an infinitely small space between the Aluminum and the Phosphor Screen. The aluminum will be held in place by electrostatic action, as well as being solidified aluminum (however thin). Elapsed time about **(45)** minutes.

SEALING THE ELECTRON GUN INTO THE BULB:

#10 First, prepare a tray (**5 X 12**), of “**DRESSED**” (see explanation of **DRESS below**), guns, to be sealed into the neck of the Bulb. That is, a vacuum may be achieved only through the tubulation, which is part of the Gun structure. Give a quick check to see if the filament is in the correct position in the Cathode Cylinder, **(2)** turns of the “**HEATER**” {**Filament**} **coil**, is optimum).

If there are more than **(2)** turns visible, use a Tweezers (on hand and needed for the sealing operation), and press the thick wires in, gently, to which the filament is attached, to the required **(2)** turns. If **LESS** than **(2)** turns, gently pull back the connecting links to expose the **(2)** turns.

NOTE: EXTREMELY IMPORTANT. When **MORE THAN (2)** turns are viewed, the Filament will be located too far away from the inner top of the Cathode Cylinder, which holds the Coating (on the surface of that Cathode Cylinder). That will affect the conversion processing (converting the Coating Oxides into Carbonates).

If the conversion process is not completed when under vacuum, then when the Tube is sealed off from the Vacuum system, that process will release additional gas, which will shorten the life of the Cathode (Tube). Also, the Filament being located further away from the Cathode will create a longer WARM-UP time, (more that **(10)** seconds, which is **NOT** desirable, when in the T.V. Set.

If **LESS** than **(2)** turns are visible, then that means that the Filament has been squeezed into a much smaller configuration, which would make it compress/enlarge, thereby making it closer to the walls or even pushed against the walls of the Cathode Cylinder. This would cause Electrical leakage, between the **(2)** Elements, { Filament in A. C. and Cathode in D.C.}. Eventually, it would cause a **“Short Circuit”** and burn out the Filament.

Next check Grid connection and cathode connection. Make sure they are **NOT** touching other elements or even un-connected. Adjust (DRESS) all wires to stay close to the tubulation of the gun. When visually O.K., fit the glass tubulation into glass tubulation-diameter holes { Sixty (60) of them, for use as needed in the Sealing Operation.

SEALING THE ELECTRON GUN INTO THE NECK OF THE CRT:

#10 Continued: When the Bulb has cooled sufficiently, it is ready for the **“SEALING”** operation. Insert the **Electron Gun** into the Tube neck, making sure the **SPIDERS** are touching the Aquadag Coating. The **SPIDERS**, because of their spring-like ability, hold the Gun in place before sealing.

Then place the selected to-be-sealed GUN into the selected Tube in a small pre-heating Oven-Box and placed, **NECK ONLY**, in that preheated **(250 F)**, which contains temperature-controlled, Gas-air fired, burners. This preheats the neck only, where work, will be done.

The neck, **(NOT** the entire Bulb), but including the **Electron Gun**, is placed in the small oven, adjacent to a **SEALING MACHINE**. The Sealing Machine joins the glass **WAFER-LIKE** part of the **Electron gun**, (which contains already-sealed wires), to the glass neck of the Tube. It does this. by melting a part of the glass

neck, (at a predetermined distance from where the neck joins the Bulb proper), into, merging/ joining the glass wafer to, the neck. into one piece.

The Electron Gun Elements/Structure is also attached to these wires. They provide Electrical contact to those Elements, which will be under vacuum, to the Voltage-providing circuits of the **CHASSIS**, which are located **OUTSIDE** of the vacuum. Time elapsed in oven pre-heat, approximately **(5) Minutes..**

#11 The **SEALING MACHINE** consists of a number of revolving “heads” (which hold the Tube, in an upright position, neck down), and a fixed-height hollow **STANDPIPE** affixed on a plate which also revolves. This standpipe arrangement, has removable parts called “**PINS**”, on the top, which may be extracted and other types put in its place. (I do **NOT** know why they call them **PINS**, because they sure do **NOT** like a PIN).

These **Pins**, may be exchanged when they wear out, because the tops of them are exposed to **GAS/OXYGEN** fires, in normal operation of the **SEALING MACHINE**. The principal reason for exchange is to accommodate different glass diameters of the tubulations (from Twenty Millimeters (20 MM) to **3/4“ I.D.**, for multiplicity of different tube sizes.

While the heads holding the gunned tubes may rotate about **15** or **20** times a minute, the plate is timed to rotate at only **(1) POSITION** per minute, { of **(6) positions**. or **(6) minutes** to make **(1) complete revolution**). In each position, there are **(1) or (2) sets** of clusters, of individual burners, in fixed positions, but with the ability to be raised or lowered, to effectuate the proper sealing process.

Each Tube position on the Plate which Slowly revolves, has upright stationary fittings, in which the Tubulation will be put into. The raising or lowering of the head fixture supporting the Tube, has a screw-like adjustment. Because of the many difference in Tube shapes (Deflection Angles), the Tube neck

Lengths vary in size (anywhere between **(3) to (7) inches**. Measurements, at the time of sealing, are accomplished by a cardboard (corrugated), marked-off ruler. Any metal used, would crack the hot glass neck.

In positioning the length and sealing the Glass of the Electron Structure to the neck, a space is allocated for the molten bottom part of the neck to drop after sealing, (of at least **(1) inch**, but **NOT** more the **(2)inches**). To assist the molten glass of the neck, to be cut away from the Gun, a **Tweezers** (about **(4) to (5) inches** in length), is used. In conjunction with air pumped into that area, the molten glass is pulled away from the sealed wafer/Gun, and discarded.

At that point, air is introduced into the Tube itself, thru the Tubulation, as to counter-act the force/pressure of the Gas/Oxygen Jets and to **ROUND** out the

area which was molten and is now starting to cool and set up. Glass does **NOT** want to have Corners. It is much stronger when it is **rounded out**.

Glass, also, does **NOT** like going quickly from thick to thin. **IF**, it must be thick for any reason, then considerable time and care should be allocated to **SLOWLY** cool (**anneal**), it.

There are at least **(2)** clusters of Gas-air positions of PRE-HEATING fires (so the glass does not crack from being too rapidly heated). Next, there are **(2)** sets of clusters of **Gas-Oxygen** fires. These fires do the actual work, (melting the glass of the neck, into that of the glass of the Electron Gun), which also contains the Electrical wire for future connections), AND the tubulation, (straw-shaped, with a **3/8"** inner diameter).

It will be used for attachment to the Vacuum Pumps, { the next step}. Then, there are, **(2)** positions of clusters of Gas-Air sets of fires (to allow the heated molten glass to slow down in the "**cooling**" process, of the sealing operation. In glass work, this cooling process is ALWAYS USED and called "**ANNEALING**".

Then the tube is placed in a "**cooling**" oven, **annealing** procedure, (neck and gun only), which is set at approximately **150 F**, so as to cool the fused glass slowly, for about **(3)** Minutes. Total elapsed time to seal **(1)** tube with a single-headed machine is approximately **(7)** minutes.

NOTE: If a **(2)** headed machine is used, then that time may be reduced to **(3 ½)** minutes. A **(4)** Headed machine may reduce the time to **(70)** seconds. High-production machines, usually have the ability, and the necessary resources to seal **(1)** Tube, per Minute.

PUTTING THE TUBE IN HIGH VACUUM (PUMPING)

#12 Now the "**gunned**" bulb is ready for the High Vacuum step and de-gasification, procedure, commonly called "**PUMPING**". The bulb, with the gun sealed in, contains the glass tubulation, as a part of the complete Gun structure, which is used to attach to the **VACUUM-PRODUCING PUMPS**. This is accomplished either of **(2)** ways:

When using Glass-Oil Diffusion Pumps, a Glass to Glass joining of the CRT and the Vacuum system is made with a gas/air torch. If instead, a metal diffusion pump is used, then the tubulation is fitted into a "**compression port**", (which is part of the Vacuum arrangement). That compression Port, is constantly water-cooled, as it IS in the heated oven. The primary, high-speed Mechanical Vacuum Pump, is the same in both cases.

The pumps are located **BELOW** the Heating Oven, (**NOT** in the gas-heated portion of the oven),but **ARE** part of the Vacuum System. The oven a (High Temperature Oven), **IS** in the **400 Degree C** , **(752 Degree F** , There are **(2)**

Vacuum Pumps for each tube to be processed (while, at the same time, they are being baked.

The reason for the (2) Pumps is, because, there is no single pump which may pull a vacuum, at an extremely high speed and achieve a high degree of vacuum at the same time. This is absolutely necessary for producing the extremely low gas-containing condition.

HIGH-SPEED MECHANICAL VACUUM PUMPS

A. The High-Speed mechanical vacuum pump, very rapidly (4) to (6) minutes, (depending on the tube size, in conjunction with the speed of the pump), evacuates the system, {which contains a secondary pump, called a (3) stage “Oil Diffusion Pump”. That Diffusion pump is responsible for achieving very low gas conditions, while being baked, and removing Gasses, as they are liberated from the processing of the Electron Gun.

Note: (2) types of oil, were specifically designated, to be used , in the diffusion pumps. The first was called **OCTOIL S**. It cost about **\$8.00** a gallon, **(IN THE 1950’S)**. But, every time the vacuum system was unexpectedly broken, (mainly due to **IMPLOSIONS**), the oil had to be changed, (and thrown away), because it could **NO**-longer do the proper job.

The **2nd** type of oil, was called **SILICONE OIL** It cost prox **\$120.00/gal**. But this oil was, **“STABLE TO AIR AT OPERATING TEMPERATURES”**. Hence, it was **NOT** necessary to take the pumps down, (disconnect them). Silicone oil did **NOT** have to be thrown away, until it got dirty, (from extraneous particles), or when ever the vacuum system was broken, cracks in the glass network or **implosions**.

NOTE: When the pumps had to be cleaned, or have the oil changed, removing them from the production line was called **“Down-time”**. Therefore Silicone Oil tremendously reduced down-time. Further Silicon Oil produced a far superior Vacuum.

In the past, **Mercury-Diffusion Pumps** were also used, but were quickly discontinued, due to Mercury’s extremely toxic nature. **Liquid Nitrogen** was necessary/**HAD** to be used, for them to function properly. It was **dangerous** to use. **AND** was hard to store..

The **Liquid Nitrogen** was stored in large **Dewars** (thermos-like bottles) [cans]. Contributing to the **Mercury-diffusion pump’s** abandonment, was the fact that it was always **dissipating**, exacerbating the high cost for usage.. The reason for the **dissipation** was, **Liquid Nitrogen’s** normal temperature is prox. **(321)** Degrees **BELOW ZERO**. There was **NO** effective insulator, to retard/prohibit it.

Large corporations, such as **RCA**, **Sylvania**, **General Electric**, etc. did **NOT** use stationary Ovens, because they needed **HIGH**-volume facilities. They employed **in-line ovens**, which could accept as many as **(60)** moving dollies, (much like a train, tracks and all). Those Ovens

had successive zones of warm-up temperatures, top temperature (400 Degrees C), (752 Degrees F), and cool-down zones

In-line ovens, could turn out (1) Tube, every (2) minutes, (30) Tubes an hour, or 720 tubes per 24 hr day. At (5) days a week, they could produce (3,600) Tubes. Some large T.V. Tube Mfg plants, had (2) of such in-line Ovens .

HIGH-VACUUM OIL-DIFFUSION PUMPS FOR GAS-MOLECULE REMOVAL FROM THE ENTIRE SYSTEM, (including the crt)

B. The Oil Diffusion Pumps, A/K/A, "FRACTIONATING PUMPS", (have NO moving parts). They are very effective, in creating an extremely high vacuum, and pulling gas-molecules out of the system, (regardless whether they are Oxygen, Hydrogen, or any other Gasses).

It packs the gasses together, and passes them on to the mechanical pumps, which in turn, expel them out of the vacuum chamber, (including the CRT), to the atmosphere. Many Gasses, are residual, or are generated, by the processing.

Myriads of gasses, were ADSORBED, (attached to the outside of the parts, materials, used in processing, construction). Hydrogen-fired gasses, were intentionally, used), which were ABSORBED, (internally), during the manufacture of the Electron Gun's Electrodes (parts), are also dealt with.

Further , there are always gasses associated with the AQUADAG, Phosphor screen, and other chemical used in the tube's manufacture, that have to be expelled. NOTE: See Later herein, the unwanted effects, (Hazardous) of too many gasses present in the operating mode.

HOW OIL DIFFUSION PUMPS WORK (basic explanation).

Oil, heated in vacuum conditions, rises in vapor form and then goes through each stage of the diffusion pump, at a high velocity. The Vapor, encounters random particles of gas, (which are always in motion). The sides of the container are cooled, so that the oil vapor carrying the gas molecules condense., thereby packing the random particles tightly together.

As the gasses are continually, efficiently, gathered together, they are then transferred to the Mechanical Pumps, where the Mechanical pump, has the ability to expelled them, to the atmosphere.

There were (3) kinds of diffusion pumps, which were popular in the 1950's, (2) of which were oil-activated.

The 1st, was a (3) stage, glass pump , which was constructed in a horizontal axis. It had (4) pots underneath and connected to the main body. Each Pot, (except the (4th) Pot, "condensate Pot", had it's own electric coil. The coil(s), was the source of heat, which was necessary to

have the oil transformed to vapor. Electricity was fed to all (3) Coils, in a series/parallel arrangement.

The (4th) pot, [1/4 the size of the other (3)], was serially interconnected by glass tubing, to, and alongwith, the other (3) pots. It is called a “**Condensate**” **Pot**. Any/**ALL** impurities, that the evaporating/condensing action of the oil gathered, (that’s how the oil-diffusion works), from all (3) stages, ended up in the **Condensate Pot**.

NOTE: The Pump was cleaned, and **ALL** the oil was changed, when the oil in the **Condensate Pot** was too dark/**oxidized**. It was proven to be **NOT** as effective, in achieving a **HIGH** vacuum, than that, which could be achieved with pure, clean, oil.

The 2nd type oil-diffusion pump, was a Vertically aligned , (3) stage, **METAL**, diffusion pump. The (3) stages were tied together, internally, with a One-piece metal insert. It had, and only needed (1) pot at the bottom, with it’s own electrical, (**immersed in oil**), **heating-coil**.

The (3rd) type , was a vertical 2-stage Glass pump, which uses Mercury, as the gas-molecule remover. For it to work properly, it is necessary to use an extremely cold medium for condensing action. **Liquid Nitrogen**, at which boils at (**-196 C**) ... (**-321 F**), was the coolant of choice.

It was air-pumped, from a large **DEWAR**, (like a thermos bottle), into a smaller **DEWAR**, (about the size of a tankard of ale). As such, it fitted around a glass **TRAP**, (strategically-placed, in the exhaust glass-network, between the **CRT**, and the pump itself.

As time wore on, during baking and processing, the small **Dewar**, fitted on top of a platform, could be raised or lowered, was continually, raised. That was to keep at least the bottom of the trap **COLD**. Therefore, **NO** mercury, **NOR** gasses, would be allowed to backflow into the **CRT**.

Worse yet, Mercury vapor, rising unchecked in the whole system, would poison the **CRT**, [phosphor-screen], and deposit on many parts in the exhaust network. That would require much clean-up, and **down-time** !

GAS MOLECULES, HAZARDOUS FOR THE LIFE OF THE TUBE, AND FOCUS-CAPABILITY

Gas causes problems, demonstrated by “**Fuzzy**” pictures. You just can **NOT** get the clean, clear look. In high Gaseous conditions, it always looks like the picture is out of focus. That is **BECAUSE**, as the **Electron-Beam** tries to go to its assigned position, it encounters molecules of gas and collides with them. That causes the **Electron Stream** to be nudged, **left or right**, **up or down**, as well as myriad combination of **ALL** directions.

Therefore the **Beam** impacts different portions of the Phosphor Screen (so many times, each second), that the **AVERAGE**, (sum of all

the different **ELECTRON-BEAM** landings), video-picture is actually displayed. Hence, you see a “**FUZZY**” (BLURRY) look, even though the Electron Stream is **OPTIMALLY**, perfectly focused).

Excessive gas guarantees a **SHORT** life for the finished **CRT**, because the cathode which contains a negative charge, attracts **POSITIVELY-CHARGED GAS PARTICLES**. These particles condense/are deposited, on the cathode coating surface. The coating underneath that deposition of **Gas Particles**, does **NOT** contain enough energy, to go through, that unwanted coating.

Therefore the Cathode does **NOT** emit **Electrons**, and worse yet, reverses the ability for **Electron**-generation, from the good Cathode coating. This then has a smothering effect, thereby causing an ever-slowng, **Electron**-generation ability.

Eventually, (short-term), it leads to the “**purported**” death of the Cathode/Tube. “**Purported**”, because, if you can get rid of the unwanted coating, it is possible that the **CRT** may last many more years. **There IS a device that can do this!** A full explanation, is located in the next paragraph.

RENEW THE BRIGHT SHARP PICTURE AND SAVE MONEY, TOO!

NOTE. It was found that even though it appeared that a **CRT** was “**dead**”, if any Technician could apply about a **1,000** volt, (**RE-ACTIVIZATION**), momentary spike, between the Cathode and **G1**. The gas-coating deposit(s), were then disintegrated. The Cathode Coating/Picture Tube, would then be able to function properly, for many, many, more years.

HEAT TREATMENT(s) OF THE BULB AND ELECTRON GUN BAKE TUBE, WHILE UNDER VACUUM

#13 The oven is then heated to **400** Degrees C, {**752** Degrees **F** }, (in stages of incremental higher heating periods), in about **(15)** to **(25)** minutes depending on Tube size/mass. It remains at top temperature for **(30)** minutes.

NOTE: Care must be taken to **NOT exceed** this temperature by too much, **because** at around **450 Degrees C**, some thin glass tubes will go plastic and will start to cave it in.

That is due to the fact, that the bulb interior being in a Vacuum, subjects the outside of the tube(s) to the **Atmospheric-pressure** of **(14.6)** pounds per square inch. Exacerbated by the extremely high temperature, the bulb begins to soften **AND** starts to cave in/change shape..

NOTE: It was found that a temperature exceeding **(380 C ...716 F)**, (while the **CRT** is under vacuum), was necessary, to “**DISASSOCIATE**” any water, still present in the CRT. (**DISASSOCIATE**, turn the water into its constituent gasses, **Hydrogen and Oxygen**). They can then be expelled from the **CRT/system**.

After the top temperature time of (30) minutes, has been met, the **Oven** is then directed to cool down (again, incrementally). **NOTE:** Glass **NEVER** wants to be heated hurriedly and **ALWAYS** wants to be **COOLED**, (**ANNEALED**), in a longer time, than that which would be normal, if **ALL** heat is suddenly removed. To ignore this rule, may cause the glass to crack and **NOT** be able to maintain a vacuum, or even worse yet, **“IMPLODE”**.

Definition of **Implode** : opposite of **“EXPLODE”**, but with just as loud a Bang/sound. Further, implosion can **STILL** hurl broken glass parts/shards, as far as (30) feet away. That is because the pieces rush to, and, **THROUGH** each other, (much like the **“crossing point”** phenomena, but with dangerous effects. Time elapsed in baking procedure, about (1) hour or so..

PROCESSING THE TUBE AND CATHODE COATING

DE-GAS THE ELECTRON GUN & ASSEMBLY, CONVERT CATHODE COATING

#14. When the Oven temperature is cooled to about **250 Degrees C** , (**482 F**), the Oven doors may be cracked open enough, to connect wires from a D.C. supply unit, to the filaments (only). Voltages starting at **6.3 Volts** are then applied .

The voltages are raised, incrementally, and ultimately, to a (30) second **“HOT-SHOT”**... (**12 V** to **13 Volts**), and then incrementally, back down again, (but never less than (6) Volts). Voltage-applied time, approximately (30) minutes. At the same time the doors are continuing, (incrementally), to be opened, (cool-down procedure).

Simultaneously, with the voltage application and the cooling of the oven, and in addition to **de-gassing** the **Electron Gun** is another very important part of manufacture namely: Supplying a different source of heat, to the **Electron Gun** itself, is accomplished by application of an **R. F.** source , a **“BOMBARDER”**. This is the **DADDY** of the **microwave oven**, in everyone’s kitchen). This device was designed, and powered, specifically, to **HEAT-TREAT** metal.

NOTE: The **KITCHEN MICROWAVE** was **NOT/SHOULD NOT**, be allowed to heat any metal. **DANGER (IT COULD CAUSE AN EXPLOSION) !**

HEAT-TREAT ELECTRON GUN, WITH “BOMBARDER” TO GENERATE & REMOVE GASSES, and ASSIST IN ACTIVATION OF THE CATHODE COATING

A **Bombarder** is an electrical device, specifically designed, to generate and project Radio-Frequency (**R F**) waves, into metallic objects. These Electro-magnetic waves, cause **ALL** molecules, (which have **North** and **South** poles, in the metal), to attempt to be aligned in One direction.

Then, the **R F Wave**, reverses itself and causes the molecules to re-align themselves, in the opposite direction. It does

this many times per second, such that the molecules rub up each other, creating friction. As a side effect, as the material gets hotter, it creates an acceleration of the heating action, "IONIC CONDUCTION", (explained below).

"BOMBARDING" THE ELECTRON GUN, WHAT, HOW & WHY ? ANOTHER USE OF A "BOMBARDER"

The **Bombarder** is so powerful, that it may heat **ANY METAL**, to a "White-hot glow. A **BOMBARDER** is used, by Industry, in many different operations. One, that comes to mind, is in the manufacture of **RAZOR BLADES**.

A CONTINUOUS BAND OF STEEL,

(hundreds of feet long), has to be "**HEAT-TREATED**", (see **quenching** below), to assure, that the finished blade, can be hardened. then the very thin, sharp edge, could retain that sharpness, thereby lasting for, more than **(1)** effective shave.

The band of steel, (much like on a conveyer belt), is run thru a fixed set of coils, which when activated, project the Microwave energy into the rapidly-moving band of Steel. When the STEEL-BAND gets "**RED-HOT**", it then passes through an "**OIL RESERVOIR**, commonly called "**QUENCHING**". Where glass wants to cool **slowly** (**annealing**), the **sudden cooling**, "**Quenching**", of **STEEL**, makes **STEEL**, **harder**.

It was a generally accepted premise, (even today **(2008)**), that glass is **NOT** affected by microwaves Having said that, glass exposed to **RF** waves, has **NO** effect on the glass, consider the following: Now, Under special circumstances, micro-waves, **MAY heat glass**, over a period of minutes, [**NOT** seconds], of micro-wave reception. With continuous, persistent, bombardment by the micro-waves, the glass, **DOES**, start to warm up.

"Ionic Conduction", is a process, where current is transported by **Ions** moving around. and [possibly] **ELECTRONS**. "**HOLES**", (lack of any charge **between** electrons), [but different than the **Electron** charge], encourages the current-flow, and the direction, the current is flowing.

"HOLES" per se, are empty spaces, existing between flowing **Electron** current As such they do **NOT** have any charge. But, in relation to the electrons, which have a negative charge, OR a positive charge [**POSITRONS**], there is a "**Difference of Potential**". The "**Holes**" provide an impetus, in **conjunction** with **Electrons**, [current], to continue flowing, and do work.

"Difference of Potential", is a term used, to describe how electric current moves through a conductor, or between **(2)** electrodes, from the Negative, towards the Positive.

As the **R F** continues to be supplied, (dependent on a number of variables), the glass will continue to get warmer, then hotter. The **Ionic Conduction, phenomenon**, will tremendously assist, the supplier of the

microwaves, to accelerate the heating process. That way, eventually, heating **CAN** occur, (dependent on a number of variables).

NOTE: If, the **R F IS** left **ON**, in your kitchen Micro-wave Oven, for **HOURS**, then, it **IS** possible to actually soften the glass. It may then mis-shape it, without any assistance of supplemental heat, from any other source).

Conductors of electricity have the ability to accept micro-waves, and store them up. The more micro-wave energy they absorb, the greater the amount of heat, is accumulated. Many years ago, as a student, I was taught that everything, conducts electricity. Some things, (such as glass), are very **poor** conductors, and therefore, were termed, **“insulators”**.

NOW, **PROOF**, that claim glass, indeed conducts, electricity is **TRUE**, (without electrocuting anyone). It is now confirmed, by what we just disclosed, the **“Ionic Conduction”**, reaction! It is interesting to see, that projecting the single micro-wave coil at your hand, produces **NO** immediate effect. But, if you have a ring on your finger, the ring, will get very hot, very quickly.

BACK TO CRT's

We do **NOT** want the **Electron Gun** Electrodes to get **“White-hot”**, because that much heat, would distort the Electrodes and disrupt distance-tolerances, vital for proper functioning of the **Electron Gun**. Further, that much heat, put into metal, while the metal is under vacuum, would increase the **“sublimation”** of the metal.

“Sublimation”, is the process where a metal undergoes a transition from a **solid** to a **gas** phase, with **NO** intermediate liquid stage.. The metal deposition, being formed on the neck of the glass tube, [opposite the gun structure], will cause additional electrical/electronic problems **Sublimation** is much like the aluminizing technique, discussed herein.

The **aluminizing** of the CRT, undergoes a process, which is the **opposite** of **sublimation** reaction, (**DEPOSITION**). Under **VACUUM CONDITIONS**, it readily goes from a solid, bar, {slug}, of aluminum], to a liquid-appearing one.

It then turns to a gas, spreading out, uniformly, in **ALL** directions away from the heat source. Finally, it condenses, (solidifies), and deposits, as an extremely fine solid -metal coating, on **everything**, (including the metal **anode button**), inside the vacuum envelope [**CRT**].

By switching a micro-switch, **“ON”** and **“OFF”**, (which controls the output of the **Bombarder**), it is possible to maintain just a **“Cherry-red”** color. This then, quickly liberates any gases, which might have been **“Adsorbed”**, (**attached to the surface of the metal**). They are then expelled, to the atmosphere.

It also causes **ALL** gasses, which might have been used, in the manufacture of the parts of the electrode and internally **“Absorbed”**, to be liberated from the metal. Then they are removed from the tube, (indeed the whole Vacuum System), by the **Oil Diffusion Pump**.

The **Oil Diffusion Pump**, has the ability to take the gasses, pack them together, and send them to the mechanical **Vacuum Pumps**, which are attached to, and part of, the whole vacuum System.

NOTE: Non-metallic parts, contained in the Gun Structure, which might **NOT** quickly react to the **R F** energy, (because of their proximity to the heated parts), are thereby also heated, **AND** release gasses.

First, the **BOMBARDER** heats the **G1**, along with the Cathode Cylinder and extraneous parts, to a bright-red degree. Each electrode is heated at that red brightness, for **(1)** Minute. This is done for **(2)** reasons::

1 of 2 For **de-gassing**, as just explained. **NOTE:** Care should be taken **NOT** to heat the **SPIDERS**. If the Spiders are heated to that red brightness, then in that case, the **Spiders** will **LOSE** their tension and probably will cause failure of the **CRT**, at a later date..(**Spiders**, enable High Voltage to be delivered from the T.V. Power Supply, to the Electron Gun).

When the tube is finished, and put into operation, at first, the Tube will function normally. Later, [as early as several weeks, because of the heat generated in the normal operation of the T.V. set], the Spiders will start to vibrate, **“SING”**, or **“chatter”**, making an audible, high-pitched, ringing sound.

The video, (PICTURE), WILL SHOW BLACK HORIZONTAL BARS ACROSS THE SCREEN and immediately be **NOT**-acceptably watch-able. Of course then, the **CRT** will have to be replaced.

But, if for any reason, the set remains on for longer than a few minutes, after the **“singing”** commences, the combination of High Voltage and vibrating Spiders **“CHATTERING”**, will actually cause the glass neck to be **“HAMMERED”** and crack.

The **CRT** will lose its vacuum and of course , **NOT** be able to function. If the T.V. Set still is **NOT** turned off, **IRREPARABLE** damage will occur to the circuitry of the T.V. set, such that, the **entire** T.V. set must be discarded.

2 of 2. To assist the Filament-generated heat, to aid in conversion of the Triple **(3)** coating oxides, into Carbonates, which are. deposited onto the Cathode Cylinder, (which is encased within **G1**). **Next**, to start uniform activation of that residual coating. Then, that converted coating, may readily produce **Electrons/Ions**, when called upon to do so.

NOTE: In the primary manufacture of the **Electron Gun**, the **(3)** coatings (in liquid form), are sprayed on by a Paint-sprayer

device. Then the deposited coating dries, and is shaped to an **EVEN** surface, with few, irregular (high spots).

Then the series of electric voltages applied, rising up, in increments, from (6) Volts to a (1) minute **“Hot Shot”** (12 ½ to 13 Volts), and then incrementally being decreased back to the original (6) Volts, completes the conversion and activation of the Coatings.

#15 When the conversion/conditioning of the **CRT** (Cathode Coating), is completed, the wires attached to the filament are disconnected. Taking care, **NOT** to allow air to be introduced into the **CRT**, the **CRT** is separated from the exhaust system, in any of the following manner(s).

SEPARATING A PROCESSED TUBE FROM THE VACUUM PUMPS (TIPPING OFF)

#15 a. The old fashion way: With a gas-air torch, heat the area, in which you want the end of the **CRT** glass tubulation to be. (Do **NOT** forget to preheat, or the glass may crack), at which point all that time is wasted **AND** the **Electron gun is** useless, {the cathode Coating is destroyed})

As the glass becomes soft and pliable, the process called (**“TIPPING OFF”**), The Atmospheric pressure coupled with the force of the Gas-Air Torch, causes the **“TUBULATION”** to start to collapse.. **TUBULATION**, is a glass tubing, (like a straw), which connects the **CRT** to the pumps.

As the **Tubulation** starts to lose diameter, the glass becomes even softer. The **CRT** is slowly raised upward, to make the diameter, yet smaller. Continuous heating/lifting the **CRT**, until it comes to as thin as a thread of string. At that point, the flame, **CAN**, and does sever the **CRT**, from the Vacuum System.

Then, the ideal end-result is like a **“hand-sharpened”** pencil called a **“TIP”**. You must **NOT**, just let the glass collapse into a thick **“BLOB”**. If for any reason, you have let it go into a **BLOB** condition, then in that case, you must spend several minutes, **“Annealing”** that **Blob**, or it will surely crack at a later time.

This separating operation, requires some strength and certainly skill, in maneuvering the torch and the lifting procedure simultaneously. See next, Paragraph **“15 b”** for the finally chosen method of separating the **CRT** from the Vacuum System.

#15 b. In order to reduce the skill [and pay requirement(s)] , certain manufacturers used a ceramic coil, containing a heating element, to be put around the tubulation, in the initial part of attaching the Tube to the Vacuum System.

When separation time came, the coil provided the following: **PRE-HEATING** the glass tubulation for **(2)** to **(3)** minutes, to bring the tubulation up to softening/melting. Then, another minute, to effectuate the complete closing off, (into a **BLOB**) of glass.

Then the coil slowly had voltage reduced, hence producing **LESS** heat (**ANNEALING**). This period was about **(2)** or **(3)** minutes. When that was completed, the coil was lowered to the part of the tubulation, still attached to the Vacuum System. With a metal file, (shaped like a knife), a **FIRM, QUICK** scratch, "**SCORE MARK**" was made to the middle of the Blob. Then a quick blow to the blob, **AT** the Score-mark, caused the glass to separate.

The tube could then be removed for the next step. The Oil-diffusion pump was shut off first, for at least **(1)** minute, to allow the Oil to cool from operating temperature. (Most Hi Vacuum Oils used in Diffusion pumps, did **NOT** like to be exposed to air at Operating temperatures).

Then the mechanical pump was also turned off. Finally air was introduced into the system. The remaining piece of **Tubulation** was then withdrawn and discarded, preparatory for another pumping operation. Total elapsed time, in the oven, {turn-around time, **(2)** hours}

NOTE: "AGING" the Tube is necessary, because the Coating has "**Hills and Valleys**", (varying portions of Thicknesses) and the thicker parts need more processing than the thinner parts. A **CRT** should last many years and **NOT** be allowed to fail, for at least, the first **(18)** months.

Generally, there was a **(1)** year guarantee given. If the **CRT** was returned "**under warranty**", then a new one had to be sent, at **NO CHARGE**, to the consumer, (but at considerable cost to the manufacturer).

LIFE-CYCLE OF THE CATHODE COATING/CRT

- A** .Initially the coating is in a non-active state and will **NOT** release **Electrons/Ions**.
- B**. As the Coating is heated (in Vacuum condition) it starts to become active.
- C**. The coating, (under a microscope), reveals many high spots, mixed in with many low spots. Therefore some areas will convert/be activated sooner than others.
- D**. When the Cathode Coating is properly converted and easily producing **electrons**, it starts out, (on its life-cycle curve), such that it gets better and better at producing **Electrons**.

If for some reason, the Cathode is **NOT** fully activated, and at or near the bottom of the life curve, the Coating will **NOT** continue to improve. In fact, it could degenerate, to even less favorable **electron**-generating conditions.

At that point the tube might be sent back on the production line for additional “Aging”. If again, it displays “unsatisfactory” readings, then the CRT, would have to be cut open and go through the manufacturing process once again, (with the Electron Gun wasted).

NOTE: Later on, those “WASTED” Electron Guns were themselves rejuvenated, by removing the G 1 Structure, (containing the entire Cathode Assembly), and replaced it with a BRAND-NEW G1 assembly.

The optimum cathode activation, would be at a point on the curve which is a little before, (but still rising), to a “Plateau, (the next level of activation).

E. When it is producing the maximum amount of electrons it will stay on a plateau producing plentiful Electrons, for from (3) to (5) years, or more.

F. It will then start on the down-slope of the curve, which should be another (6) months or so.

NOTE: When the Cathode Coating is OVER-PROCESSED, you may be, well across the plateau, or even on the down-slope. It could even be BEFORE, the CRT is installed in a consumer’s T.V. This failed CRT, entitles the consumer, for a free replacement (Warranty).

G. Back to a state where electrons may NOT be generated (coating expended). Failures in the manufacturing are known as “SHRINKAGE”. Those CRT’s have to go through the process all over again

ACTUAL AFFIXING OF BASE AND “AGING” OF CATHODE COATING.

16 The Bakelite cement originally comes as a powder. When mixed with de-natured alcohol (easy, non-contaminating, evaporation material), it is worked to the consistency of “peanut butter”. A 1/4 ‘ thick ring of bakelite cement is applied inside the bakelite base, which also has hollow metal pins fixed in place..

The wires from the Electron Gun are threaded thru those metal pins and pulled tight to mount and fix the bakelite Base and cement, to the glass of the CRT neck, where the Glass-like Wafer of the Electron gun was melted into the neck, which also protects the Glass tip.

Those wires also hold the base on straight, until the alcohol is evaporated and the bakelite cement becomes as hard as plastic. It turned out when tubes were separated in the Blob configuration, it became a good idea to coat the blob end with a High Vacuum, Red-Paint, sealant.

This was proven, to effectively stop, minute, air intakes remaining, in the center of the blob. It was NOT necessary, with the hand-separated type CRTs, in the beginning of the base attachment process.

At the same time , as part of the Cement-hardening process, the Filament wires are again connected to an **A C** supply. This will further age the cathode, (with the obligatory **“hot shot”** for **(30)** seconds), as well as to assist in the hardening cement-evaporation procedure.

In winter climes, depending on the ambient room temperature, sometimes, a **“spot light”** shining on the base, may be necessary, to complete the base-hardening process.

At **6.3** Volts A C, the filament generates approximately **800** Degrees **C** of heat, or about **1472** Degrees **F**, (and higher). As voltages were incrementally advanced, the Glass in the base area gets hot to the touch, thereby hardening, the **Bakelite Cement**.

When the **Bakelite cement** is hardened, then the socket (called a **BASE**), containing the wires is firmly affixed to the end of the **CRT** neck. Next, the wires are snipped off at the top of the pins and lead-soldered, (so as to assure connections with the pins are securely, permanently made).

Time lapsed about **(30)** minutes from the last tube connected. Usually the process is done in Oven loads or **(20)** to **(30)**tubes, tied in parallel together, to the A C Power supply. Aging, base-hardening elapsed time, approximately **(30)** minutes.

GETTING RID OF PARTICLES WHICH MAY BE ON THE ELECTRON GUN PARTS

#17 On a tube holder, the **CRT** is placed, (face up, neck down), and a socket is plugged in to the metal strips of the base, in which all pins are joined together by a heavy-duty wire. This other end of the wire is anchored to **“GROUND”**.

Another heavy-duty wire is connected (Clipped in) to the anode The Anode is fed to a device which produces **“HIGH VOLTAGE”** { H V.}, **(25)** to **(35)** Thousand Volts.

By a piece of equipment, (commonly called a **“SPARK-KNOCKER”**, **THAT DEVICE** could send high voltages/high current from it, to the **CRT**, THEN TO GROUND.

When turned, on the **H.V.** disintegrates any material, still present on the Electron gun,(with a (CRACKLING) sound . That sound was made by the electricity disintegrating the particles. Larger tubes got the **35,000** volt treatment, because the T.V. sets they are placed in, normally deliver more **H V**, to work properly, than that of the smaller ones.

TESTING THE FINISHED PROCESS

VARIOUS VOLTAGES, OF VARYING INTENSITIES, INHERENT IN TEST SET

#18 Testing the finished product was accomplished by connecting the

finished product in an T V set-simulating equipment procedure. All voltages (and current drains, and then some) are available and dial-monitored, by controllable sources.

For example: High Voltage was supplied from **Zero (0)** volts, all the way up to **(35,000)** volts. Other variable voltages available in the **TEST-SET** were:

Filament voltage from (**0 V**) to (**15 V**)

w/ automatic current drain (from **200** to **800** Milliamps)

G1 (**0 V**) to **80 V**

Cathode (**-10 V**) to (**0**) V + current drain (called “**EMISSION**”), the aggregate of electrons passing from the Cathode though the aperture of **G1**), in **MICRO AMPS**.

G 2 (**0 V**) to **500 V**

Focus Ring (**0 V**) to **450 V**

Anode (**0 V**) to **35,000 V**

NOTE: There is a relationship to the amount of Electrons passing from the Cathode, through **G1** and the amount of voltage necessary to completely halt that action.

That also means, that that varying the voltage, according to the signal received from the Transmitting source, may allow varying amounts of **Electrons** to be sent to impact the Phosphor Screen, thereby drawing the picture and making the picture darker or lighter.

The **TEST SET** has the ability to test for “**LEAKAGE**”(electrical), between the Cathode (A.C.) and **G1** (D. C.) measured in Micro-amps. Too much leakage (above **(10)** Micro-amps, would be indicative of the Filament, non-conductive coating was damaged. It should be rejected because, with time/use, it would only get worse.

Eventually it would introduce a **(60)** Cycle “Hum”, (usually **VISIBLE ON THE** phosphor Screen, as a series of fuzzy, wavy, lines in the Picture, (undesirable). (See **SEALING the ELECTRON GUN** hereinbefore, to **PREVENT** leakage).

CRT: CROSSOVER OF ELECTRON BEAM !

In conventional **CRT's.**, the active coatings, (from which the electrons, [and other particles], are generated), reside on the top,(cap), of the cathode cylinder. This cap always has a **larger** diameter than the aperture [hole], (in **G1**), situated immediately above the Cathode coating The (**G1**), controls the amount of **electrons**, (emanating from the coating), which pass through it !

Therefore, particles (**Electrons & Ions**) generated from the coating on the cap, **NOT** having un-impaired access through the aperture, must be forced to do so.

In effect, (for ease of explanation, let's just name **ELECTRONS** only) this activity basically calls for a **"splitting"** of the **Electron stream**.

Then as the **split-beam** is passed through the second controlling grid (**G2**), of the **electron gun**, [on its way to impinge on the phosphor screen], the **electrons** which are crossing through the main **stream (beam)**, attempts to **join** together, with the **electrons** which came from the unimpeded part of the **electron stream**.

But it does **join** up with the main **stream**, but the energy (coupled with the inertia contained therein), forces it to continue to go on crossing **THROUGH**, and beyond, the main **stream**. In effect, that results in another **splitting** of the **electron stream**, until, and unless, something can bring it back together again.

Now the **beam's**, diverging particles, attempting to **split** the **Electron stream** again, enter the anode structure (the **3rd**), main structure of the Gun. They are accelerated, but then encounter a magnetic field, generated by, and called a **"focus"** coil.

This coil is a correcting attempt, (either internal or external, depending on Gun Type), to unify the **stream**, once again. Normally the voltages responsible for manipulating this process, **joins** the **Electron Stream**, together again, so that the **Electron stream** in unity, may do its assigned task.

Ideally, the re-unification of the **stream**, may be fixed to occur directly, as it impinges on the Phosphor screen. This action, may thereby produce a clear/sharp image. (except for **HIGH** gaseous conditions). See later herein.

Once again, **too little** focusing voltage, causes the united **electron stream** to join together, **BEFORE** it impinges, directly on the screen. Conversely, **too much focus** voltage, would effect a **"crossover" before**, impinging on the Phosphor screen. The final result, in both cases, [in attempting yet, a **3rd** **"crossover"** effect], would be a (**blurry**) picture.

I never did determine, what effect with having the Cathode Cap, AND the **G1** aperture have, if they were both of, the **same** diameter! Then, there would **NOT** be a first **"crossover"** point necessary. At that point, **ALL** electrons would have unimpeded access, to go through that **G1** electrode., in response to accelerating informational- containing voltages. Hence ? **NO 2nd**, **crossover** needed **NOR** would there be a **3rd crossover** needed/ generated ? ! ? !

ASSESSING THE POSSIBLE LIFE OF THE CRT

The Test-set also has the ability to disengage the **"SWEEP"** circuits. This was a

valuable tool, in assessing the effectiveness of your manufacturing process, because it enabled you to see a “**PICTURE**” of the surface of the cathode coating, which was called the “**CATHODE IMAGE**”.

The actual coating was concealed from visible sight because it was an integral, part of the **G1** assembly electrode. To get a view of the Cathode Coating, first, cut the **Focus Voltage** to **Zero Volts**. Next, the “**SWEEP CIRCUITS**” were automatically dis-engaged. Then the **HIGH VOLTAGE** was cut from **15,000 Volts** down to **5,000 Volts**.

Physically dialing down a rheostat, lowered the **Focus Voltage**, (which was able to be varied from **450 Volts** down to “**0**” Volts), to “**0**” Volts produced the following effect:

When the voltage was reduced to “**Zero**”, (**DEFOCUSED**), the **Electron Stream** was precluded from achieving the second “**crossover-point**” point. That action resulted in the **Electron Stream**, continuing its “**funnel**” expansion, culminating at the Phosphor Screen, as large as, a Silver Dollar.

CAUTION: If you do **NOT** reduce the **Focus Voltage** to **Zero** first, you will ruin the Phosphor Screen in a split second, (**instantaneously**). When the **Sweep circuits** are dis-engaged, a tiny focused pinpoint of the **Electron Beam**, (which is supposed to be moving, to “**draw**” the pictures), causes all the **ELECTRONS** to impact one tiny area of the Phosphor Screen . This, will **BURN** a hole in the Screen.

This makes the **CRT** unacceptable, for viewing. Worse yet, leaving the focused spot **ON**, for longer than (**5**) seconds, actually starts to burn a hole in the Glass Bulb itself. Then the whole bulb, is useless and must be thrown away.

SOMETHING TO THINK ABOUT:

Let us enlarge the conventional average “**STRAIGHT**” Electron-gun **100** Hundred times. **NO** Container needed, as the Glass Bulb of a CRT. In effect, the Universe will be the Container

AVERAGE GUN

5 Inches

Filament Voltage **6.3** Volts

Filament Current **.600** (Milliamps)

G1 Aperture **0.020** inches

G1 Grid Voltage Average **40** Volts +

Anode Voltage **25”** C R T **18,000** Volts +

Extrapolated **100** times larger/stronger

Approx **40** Feet (actually **41.66** feet)

630 Volts

60 Amps

2 Inches

400 Volts +

180,000 Volts +

Average “**THROW**” Distance between TOP of Anode, TO Phosphor Screen
APPROX **2** feet **200** Feet (Expected Focus Point)

From the experience with normal CRT's, the "Crossover-Point," may be well past the glass face of the 25" CRT, say, conservatively 6 Inches x 100 = 's (50) Feet

There fore the beam should be effective at, for at least 250 feet [85 (rounded up from (83.333) Yards], approx. 3/4 the length of a football field. Actual experience, increased voltages, can extend the "Focus-Point, even further.

NOTE: Since a "Straight" gun arrangement is envisioned here, the Electron Beam shall also include their "heavy-weight" brothers, the Ions. The impact of the focused Electron Stream, (ELECTRONS ALONE), shows the power, that might be unleashed in a FOCUSED ELECTRON STREAM (BEAM), in a VACUUM. Imagine a focused ELECTRON BEAM, in a Vacuum environment, being propelled by (500,000) Volts, or MORE ! ? !

IS N A S A LISTENING ? ! ?

Back to Testing/scanning , the image cast upon the screen (about the size of a silver dollar). It is able to be "READ", like an M D, reads an X-ray. To a skilled person, this Cathode Image "SCAN", was remarkably accurate, in culling out tubes which were bound to "FAIL".

It also showed others, that need additional aging of the Cathode coating. If the processing was done right, in all stages, then 98 % of all tubes passing the TESTING stage, would last longer than (1) year.

Each CRT tested was scrutinized for Screen Defects; Glass scratches (which were to be removed using grinders, in conjunction with "Jewelers Rouge"); a (10) second warm-up time period, (for a raster to appear). The amount of Electrons emanating from the Cathode ,(which showed up as Current drain in Milliamps).

The G1 Voltage necessary, to extinguish the Electron Stream from view (called Cut-off Voltage), having a proper range of G1 Voltage, to the amount of Emission of Electrons from the Cathode.

The ability to focus/de-focus the Electron stream, and finally the ability to withstand "Spark-knocking" episodes, (disintegrating fine particles of phosphor, which may have migrated down.

POLISHING THE FACE OF THE FINISHED CRT "BUFFING"

#19 SCRATCH REMOVAL: The face of the finished CRT is carefully scanned for scratches or other blemishes in the Viewing areas. If found, a Grinding wheel removes the deep scratches, be creating a number of less deep scratches.

Then, a less grainy grinding disc, removes those smaller scratches with the effect that now the face is left in a fine haze. Then a Felt polishing wheel, assisted by JEWELERS ROUGE, POLISHES the haze, so that it

completely matches that, of the rest of the Glass face. **NOTE:** This operation, takes a high degree of skill!

MAKING THE CRT “IMPLOSION-PROOF” (LAMINATING).

20 Since there were many accidents because CRT's “**IMPLODED**”, THE public demanded safer CRT's. The “**QUICK-FIX**”, was to provide a system called “**LAMINATION**”. (lamination ... different types of Epoxy Resins, which functioned with other materials as a “**glass-glue**”). There were several types used.

ALL, laminating materials . required the use of **EPOXY RESINS**. Some resins, became hard as a rock. Others resembled a heavy **Jello-type** of texture. Still another was of **optical-quality**. That approach was used by **Corning Glass** and other Glass makers to make a “**dish-like**” cover to contour the bulb in question.

The **CRT**, with the matching face-plate, is heated in a small Oven, to approximately **200 degrees F**, for several minutes. Then the **CRT** and the matching Plate, are suspended in a **JIG**, so that there is approx **1/4 inch** space difference, between them.

An appropriate, clear-view (relatively pliable, when set-up), **Epoxy Resin**, consisting of **(2)** separate fluid components, are mixed together. This initiates a chemical reaction, which starts to heat up rather quickly, **(2)** to **(3)** minutes.

The ever-heating **2-part, Epoxy Resin**, is poured, gently, (so as to **NOT** make air bubbles), between the contoured plate and the **CRT**. The **Resin** takes about **(3)** minutes to harden/set-up, (in the firm, binding, yet pliable state.

NOTE: Both the **CRT** and the plate, to be attached, should be heated up to approx **250 Degrees F**. If they are **NOT** heated, it **will** interfere with the ultimate “**stickiness**” of the finished product. Remember, the process of the two separate resins (Part A & Part B), is a heat-causing chemical reaction.

If **NOT** brought up to the proper heating temperature, the end result, would **NOT** achieve the desired firmness, (**stickiness**).

Yet another way, provides different types of metal banding , (including non-resin coating, compression **BANDING**. The other types of metal containment use another type of Two-part **Epoxy Resins**, to **EPOXY** (Glue), those metal pieces to the Glass.

This is the “**hard as a rock**” variety. Whatever system is used, they are all **100 %** reliable, because ALL the systems hold the Glass together, when a blow is delivered with force to the Bulb or when it is accidentally dropped... **ALL**, very **effective**.

PREPARATION FOR SHIPPING:

SPRAY-PAINT COATING (AQUADAG) ON OUTSIDE OF BULB

#21 The last step before boxing for shipping, was to have a black highly-conductive Electric coating, (AQUADAG-like), sprayed over the entire outer Bulb area. Care should be taken that the conductive coating, should **NOT** be within a (4) inch circle of the **ANODE BUTTON**, and **NO** closer than a (5) inch circle, from where the neck, joins the bulb proper.

That is where the **YOKE** will reside, This electrical paint coating enables the **CRT** to acquire a **Capacitive-effect**, (stores electrons). It will give a smoother working action, to fluctuations in voltages), usually due to external sources.

NOTE: Whenever the back cover is removed, care should be taken, that you do **NOT** come into contact with the Tube Anode, while the Tube is in operation. It could give you a very bad Electrical jolt. Under certain circumstances, it has **actually killed people..**

NOTE: When you remove the rear cover, you also disengage the electrical circuit, (called an **“interlock”**), which powers the T.V. from your **110V** house socket. However, with the proper wire and part, the interlock can be completed, so that a serviceman may be able to work on the Chassis, (in your home), or in his workplace.

Before removing the tube, however, **ground** the anode button to an external source of **GROUND**, or even the metal chassis of the T.V. set. Even after you have grounded the tube, when you finally remove it from the T.V. set, the capacitive retention ability of the CRT, {capacitor-action}... still stores electrons, [electricity].

Therefore, it could **STILL** give you a good jolt. That **WILL** shock you, **NOT** kill you, but **STARTLE** you. That might even cause you to drop the **CRT**. If you are dealing with a non-laminated **CRT**, THAT ACTION ITSELF, **COULD HURT YOU !**, because it could ... **IMPLODE.!**

END OF THE PROCESSING OF THE CRT.

ADDENDUM

DYING (almost dead) TELEVISION TUBE MANUFACTURING INDUSTRY (1980)

There are only a few instances left today, where Television Tube manufacturing ability is left/needed, which have **NOT** been supplanted today, in favor of **“Flat-Screen“** Technology. Now (Circa **2,000**), we are blessed with **L C D**, **Plasma-type** and **Projection** T.V. variety.

Even the **projection-type** T.V. sets, are being phased-out, ... primarily, because they are too bulky.

Another important reason, contributing to their demise, is the fact, that you still need (3) cathode -ray tubes, (5” round), [per set], to achieve the color reproduction on the screen. They are ALL single , (1) color-screened tubes. You need (1) All RED, phosphor screen, another ALL Blue , Phosphor screen and the 3rd, an ALL Green, phosphor screen.

METAL PICTURE TUBES ALREADY A DEAD ISSUE !

Television-set manufacturers are always concerned with “upgrading”, “Costs”, “Weight”, “Competition”, and last, but NOT least ... “profits”. A good part of the cost of producing, selling and delivery, involve (2) very important considerations. The 1st is weight. The 2nd is bulk. We will deal with weight first.

To combat the weight problem, the industry resorted to metal tubes. The metal tubes were many pounds lighter, (especially in the larger tube sizes). A typical glass 21” tube, could weigh 40 pounds, while the 21” metal weighed 25 pounds. Even then, the next battle was to cut the bulk of the metal tubes (ALL), tubes.

They then proceeded to cut the length of the tubes, by increasing the “Deflection” angle of the Tubes, (metal, alongwith glass). “Deflection” is the amount of angle, that the yoke must deflect the Electron Stream, to achieve a viewable picture.. We will deal with Deflection later herein.

As NEW tube-types were introduced, they received letters of the alphabet, which would signify characteristics of the newly-designated type.(s), broken down as follows: Final Neck length; Filament voltages and current; Grid and focus voltages; Deflection angle; Gun Type; Bulb shape; and phosphor type, [which included the type, tint, and persistence]. At the time of the advent of “Flat-screens, there were several hundred different types.

Metal Tube types introduced over the years, included a 12” round; 16” round(s); 17” Rectangular; 19” Round; 21”rectangular; and a 30” round, (table size), monster.

NOTE: This 30” tube type was preferred by the U.S. Navy, to be used as a RADAR TUBE. When this tube was laminated, Naval personnel could plot course, direction and other information, (relative to their needs), right on top of the faceplate of the tube itself.

They would use a special crayon, designated as a “China-marker”. When the information was NO longer needed, it was easily, and cleanly erased, ready for the next plot.

The manufacturers out did themselves, when it came to the 16” round metal type. They cut the weight and the bulk problem, at the same time, in the following manner: New types of tubes, were designated by letters of the alphabet, after the tube size, to wit.

A (16 A P4), consisted of a metal cone, which was approx about (18 " long), and had a long neck, commensurate with a (60) degree deflection angle necessary for the tube to work properly.

Next, they made a 16 E P4. That consisted of a metal cone, which was approx (15" long), had a shorter neck length, commensurate with a (75) degree deflection angle, necessary for the tube to work properly. **NOTE:** They saved weight on the smaller size cone, (while preserving the viewable area of the (16") diameter faceplate).

At the same time, they cut the bulkiness of the T.V. set. Generally the overall length of the **CRT**, determined the depth of the T.V. set

Then they proceeded to manufacture the (16 G P4). That consisted of a metal cone, which was approx (12" long), had a shorter neck length, commensurate with a (85) degree deflection angle, necessary for the tube to work properly.

NOTE: Again they saved even more weight on the smaller size cone, (while preserving the viewable area of the (16") diameter faceplate). Simultaneously, they reduced the bulk of the T.V. set, because of the shorter cone AND the shorter neck length.

Segueing, to manufacturer's machinations to fool the Public and get more money for less product, consider the following: A (16") round metal tube, was measured by the diameter of the faceplate.. A (17") Rectangular Tube, was measured catty-corner.

There was actually **LESS** viewing area, on the (17") rectangular, than on the (16") round . This way, the manufacturers of T.V. sets would demand and receive more money for the supposed larger-screen T.V.

BACK TO METAL TUBE FABRICATION

Special manufacturing steps, required to process metal tubes, in addition to, the normal CRT processing.

Preparing the metal cylinder [CONE], for the 1st step: To prevent rusting or oxidation, the metal cones were heavily greased up. To remove that grease, it was necessary to use a dangerous solvent, called Carbon-Tetra-chloride. Only enough cones were cleaned, as was needed, for the day's production.

SAND-BLASTING

A glass-funnel-like arrangement, is to be attached to the smaller side of the Cone, which includes a preformed glass neck also. A "faceplate", will be fitted in/attached, to the larger opening. Therefore both receiving ends, are heavily sandblasted., for (2) reasons.

The **1st** is, to make sure, that all traces of any substance, remaining on the edges, are removed !

The **2nd** is, to rough-up/etch, an other-wise smooth metal, so that there are tiny “Pits” and “Valleys”, in the metal surface. It would then, be more receptive, to its amalgamting with glass.

NOTE: Care should be taken **NOT** to touch those areas with your fingers, as that would leave an oily residue, **NOT** conducive to amalgamating with the glass. Even then, with sand-blasting alone, the glass will **NOT** stick to the glass properly, because of the “**Difference of Coefficients.**” between the glass, versus the metal. Therefore, an interface must be found and used.

EXPLANATION OF “Coefficients of Expansion”

When **glass** is **heated/cooled**, it **expands/contracts** at a certain rate. Similarly, **metal** has its own (much faster), **expansion/contraction** rate. When that is attempted, with **NO** assistance/intervention, far too many tubes will **NOT** be successfully mated..

GLASS LATHE, FUSES GLASS CONE TO METAL CONE.

Research by **Corning** Glass, has come up with a material called “**Frit Glass**”, which solves the problem. Its **coefficient of expansion**, is **less than** that of **metal**, but **more than** that of **glass**. **Frit-glass**, comes in a powder-like form.

First: The **FRIT** is placed between the **SMALLER-side** of the metal cone and the pre-formed glass cone,. It is then heated by gas-fired jets, which enables those **(2)** pieces to be mated. Much **SKILL** is needed in this operation!

Next: When sufficiently annealed, it then proceeds to have the faceplate mated, to the **larger opening** of the **Metal Cone**.

The **Metal Cone**, now fitted with the glass cone and neck portion of the Tube, was made ready to have the faceplate sealed in. Again, **Frit Glass**, was applied to the receiving edge of the **Metal Cone**. On a specially designed machine {more in a minute}, the neck portion of the Tube, had access to an operator-controlled air stream.

FACEPLATE MATING WITH METAL CONE

Whatever size and shape, the machine had spinning capability, as well as **(35)** to **(40)** **Gas/Oxygen-fire jets**, positioned around the tube, to melt the metal rim, such that the glass was made molten. It was then able to adhere to the **Frit-laden** metal edge.

Since the Tube was in a face-up position, as the glass became heated, and became molten, gravity would make it start to sag in. Then a measured amount of air introduced into tube, (controlled by the

operator), provided an equal, but opposite force, so as to prevent the faceplate from falling into the cone. Too much air, would result in the glass being stretched too thin.

Therefore, again, a **SKILLED** operator, was needed to perform that operation. Round Metal tubes, to be sealed, only required a straight-forward piece of equipment. Rectangular **Metal Tubes**, required a **MORE** complex machine . It had to have spinning-capability, alongwith **“INDEXING”** of fire-jets, to accommodate the rectangular shape, of the metal tube.

“INDEXING” EXPLAINED

You couldn't set the jets up the proper distance from the **short** side of the rectangular tube, because then when the **long** side spun around, it would slam into the Jets. Conversely, you couldn't just set up the Jets to accommodate the right distance for the **long** side, then the fires would **NOT** be effectively set to heat the **short** side.

This method was much like the problem, during the **1st** World War, where a machine gun firing from the front of the airplane, would shoot the propeller off. The Gun, was made to fire **ONLY**, when the propeller was out of the way. That was an example of high-speed **indexing!**

Therefore, the jets were set on a pivotal part of the machine, which allowed the Jets to swing **OUT**, for the **long** side , and **IN**, for the **short** side of the **Metal Tube**, in an indexing procedure.

When the face-plate sealing was completed, The operator donned large, thick asbestos gloves, picked up the tube, and place it in a **“cooling” (annealing)**, Oven, (set at **200 F**), for about **(15)** minutes.

Then, it was placed in another enclosure, with **NO** heat supplied, and allowed to slowly further cool down, by itself.

This was a slow process, as the **CRT** was then in a closed structure. Heat emanating from the just-finished sealing operation, heated the entire interior, thus slowing down the cooling, **BUT did** an effective annealing-operation.

THEN

BEGIN THE NORMAL PROCESSING, LIKE A GLASS CRT.