

# Television Manufacture and Repair

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**Television picture tubes (CRT's): black and white components, manufacturing steps, uses, and detailed description/instructions of how to process the cathode ray tube (CRT).**

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## **COMPONENTS OF THE PICTURE TUBE (CRT)**

**Glass Bulb; also known as Bulb, Tube, or CRT**

**Electron Gun, with associated Components, See Electron Gun below.**

**Phosphor Coating**

**Liquid-paint, Inside Conductive Coating , A/K/A (Aguadag or Dixonac)**

**Bakelite (Plastic) Base**

Spray, Outside Conductive Coating

## **ELECTRON GUN**

### **Parts of an Electrostatic Focus Electron Gun, (in order of sequence)**

**Glass Wafer** with encapsulated wires, for External/Internal access, to the Gun proper. The internal connections, consist of thick, stiff wires, attached to, supporting Glass, (2 or 3) Rods, (depending on gun type), which hold the gun components, rigidly in place, (vital). Other of the stiff wires, supply a base for connections to the components. For external use, (NOT under vacuum), soft, copper wires, are extended from the bottom of the Glass Wafer, (to which a Bakelite Base will be attached in a later operation). This base, will provide easy electrical access, (from the chassis), to the elements of the Gun.

**Filament:** is a wound tungsten element, (much like an element in a light bulb), coated with an electrical, non-conductive, coating. The filament produces heat, (more than **1,472** Degrees F, at **6.3** Volts, @ **600** Milliamps ). For proper conversion/activation of the coating, increased voltages are necessary, {as high as **13 1/2** Volts}. The coating, resides atop the Cathode Cylinder, whereas the filament resides INSIDE the same Cathode Cylinder Electrode. (More about this in the Next PP).

This initiates a process called "Thermionic Emission", (which releases, in a cloud-like form, many, many, Electrons and Ions). These particles are then propelled, through the 1st Grid aperture, accelerated by and through the 2nd Grid aperture, formed, directed and focused, by other associated elements, inherent in the Electron Gun, (See the following additional components):

**Cathode Cylinder:** Hollow metal electrode, {which is enclosed in the G1 structure}, the top of which is coated with a mix of 3 chemical coatings. There is more about the composition and explanation of the 3 coatings, later herein). Those coatings readily emit Electrons/Ions, when heated in a vacuum. The filament, [just described], is situated inside that cylinder, which supplies the heat needed, for the generation of the Electrons/Ions.

**First grid [G1],** controls the initial quantity of Electrons/Ions, which will be released by the Cathode-generated Electron/Ion stream, on command from a Broadcast signal, sent from an external source. Then, the potential difference, between the Cathode and G1, starts to accelerate that stream, into the influence/region, where the Second Grid takes Command. See Second Grid, [G 2], in the next PP, and see ALSO, the Analogy, (later herein), between driving a Car and the working of the Electron Gun.

**Second grid: [G2],** accelerates the Electron Beam (Stream), even faster, to, and through the Anode Electrode.

**Split-anode:** where 2 structures are physically separated, but joined together, {electrically}, with a wire, {so as the 2 structures, may be considered as one and the same, voltage-wise}.

**Note:** In electromagnetic-focus electron guns, focusing is achieved by the use of a permanent magnetic-generating device, attached to, (or part of), the YOKE, which encircled the outside of the neck of the CRT, (like a ring on your finger). This is commonly referred to as THE FOCUS COIL. These types of guns have a one-piece, Anode structure.

**Focus ring:** A metallic ring, appearing, (but not connected to), and residing, between two structures, {see above, "split-anode"}. This type of gun was called an "**Electrostatic Focus Gun**", indicating that focus was achieved INTERNALLY, automatically, as it was part of the Gun-structure assembly itself. It was responsible for SHAPING the Electron/Ion Stream, which ultimately reduces the Electron Stream to a pin-point DOT, exactly at the point of impact, on the Phosphor screen. The necessary voltage to create the required magnetic field, which did the work, was provided by the circuitry of the TV set. See "**Magnetic Focus Electron Gun**" below.

**Crown:** The very top of the Electron Gun [Anode], (cylinder), upon which "**Spiders**" and "**Getters**" are attached. See next:

**"Spiders":** 10 to 12 pieces of bendable metal,( shaped like a spider's legs ), emanating in a full circle, from the Crown , (TOP) of the anode. The **Spiders** made contact with electrical coating, which will be put inside the tube (glass envelope).

**Note:** The **Spiders'** primary 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**), necessary for the tube to function properly. The Aquadag, highly electrical-conductive coating, is painted over the metal button, ("anode button"), which is melted into the side of the glass bulb. This **Anode button connection is common to both the inside and the outside of the bulb.**

When a heavy-duty wire, emanating from the high-voltage supply circuit of the T V set, is attached to it, the electrical circuit is completed, providing High Voltage to the Electron Gun part. Unfortunately, it is ALSO called the "ANODE", alongwith the Gun structure element. The secondary use was, that it held the Electron gun in place, during the SEALING-in process, linking the Electron Gun, into the Bulb, (described later herein).

**"Getter":** A "U-shaped" element, with a bar across the top, attached to, and sitting upon, the very top of the "Crown", (top part of the [Anode], Gun Structure). This bar contains an element called "Barium". The bar is heated up, by an external source of radio-frequency waves {"R F"}, (much like a kitchen microwave oven heats microwavable products ). Except that, that the type of R F equipment, supplying this energy, was meant specifically to heat metal. The R F applied, was from a hand-held coil, emanating from the R F generator, [BOMBARDER], which is attached to a non-conductive, pole-like stick, which is meant to isolate you, from the Electrical energy, when in use.

**That application of R F, is done immediately after processing the Gun, [Cathode coating,] and removing the CRT from the Oven [Tipping-off]. When the R F heats the Barium, embedded in the Cross-piece, it activates it. This causes a Chemical reaction, which absorbs any gas, remaining inside the CRT. It also leaves a deposit, on 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, [by R.F. heating of the Getter] , it has the ability to absorb any/all gasses. If few gasses are absorbed, the inner side of the glass neck, where the getter is located, assumes a BRIGHT SILVERY LOOK, [like a highly-polished mirror]. If there is a poor vacuum, and/or, a high gas content, a smoky-black or dirty-brown coating, deposits on the neck, instead of the bright silvery effect.**

**Later on, when Oxygen enters the tube, {for any reason}, the coating, (whether silvery, smoky-black, or dirty-brown), registers its appearance on the glass neck, by another Chemical reaction, hereby becoming CHALK WHITE. If high voltage is presented to the CRT at THAT time, large sparks (and splats), are heard, seen, (like lightning bolts ), bouncing between the elements, (Grids and Gun-Anode of the Electron Gun ). At that point, the CRT will NOT function. If left on long enough, damage to the electrical circuitry in the T V set, will ensue, to the point, if left on yet, even longer, the entire T V set, will have to be scrapped. ( See Bombarder later on herein,... SPIDERS singing and hammering the neck of the CRT ).**

**All of these elements, are provided a way, to have Electrical charges introduced to them, via a Wafer-like glass piece, (as previously disclosed), which is attached as part of the Gun structure, and supports all the Gun Elements. They effectively provide the leads, from the outside, (the T V chassis), to the elements themselves, which are inside the vacuum. Those voltages are necessary, for the CRT, to function normally.**

**"Yoke": Last, but not least, and NOT a connected part of the Electron Gun, but necessary for the Gun to be properly operated, is a series of coils,(although constructed as one piece). It is positioned on, and around the outside of the neck of the CRT. When the CRT is inserted neck-first into the yoke, the yoke is positioned snug up against the bulb, where the neck of the CRT, joins the bulb proper. In normal operating conditions, when different voltages are applied, according to instructions from the signals received, such causes the Electron Stream to be directed, left-to-right,(horizontally), and up-and-down (vertically). Note: in some TV sets, an external focus coil, [magnetically-focused], is also attached to the Yoke.**

**The Yoke function/arrangement,(NOT including the Focus coil), is generally referred to, as "SWEEP CIRCUITS". ( Given that name because the Yoke is responsible for the Electron Beam to be "swept", [Horizontally], from left to right, AND to be "swept" [Vertically], from the top of the screen to the bottom of the Screen). It is responsible for breaking up the picture into 525 evenly spaced Lines, of information, (American System), versus 1,080**

lines for the HDTV System, (which provides more detail), than the 525-Line System).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 "split Anode" parts, as indicated earlier, but a single gun structure, (Electrode), simply noted as the "Anode". It also did NOT contain a "Focus Ring" as an integral part of the Electron Gun, as focusing was achieved by another coil, constructed as an integral part of the Yoke, which encircled the outside end of the neck of the CRT .

**NOTE:** An "ELECTRON", is a single part, of an atom. Lately, (circa 2006), the Scientific Community believes that a NEUTRINO, (which can pass through all of earth, WITHOUT encountering any other particle, including Electrons), HAS MASS. It has also been calculated, that ONE Electron weighs as much as 5,000 Neutrinos. The point hereby taken, is that if a Neutrino has mass, then of course, the Electron has mass.

An ION consists of at least One complete Atom, which is called a "Monatomic Ion" containing many parts. Other IONS may also be composed of a bunch of atoms; these are called "Polyatomic Ions". It has been calculated that Monatomic Ions, might weigh as much as 2,000 times, or more, than an Electron. Therefore, Polyatomic Ions might weigh as much as Ten Thousands, or more, than an Electron. Ions with negative charges are called "Anions", and positively-charged Ions are called "Cations". The type of Ions, released from the Cathode Coating, of course, depends on the type(s), of Coatings used, to compose the Coating. (Generally, the 3 coatings will consist of a combination of any of the following chemicals: Calcium, Barium, Strontium or Cesium, dependent on the Gun Manufacturer's preference/choice).

Electrons are easily manipulated, whereas Ions, (many times heavier than Electrons), as just disclosed, 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). Ions, in a Vacuum, when concentrated, can be a very DESTRUCTIVE energy force, particularly on the Phosphor Coating. The Phosphor Coating, was meant to display video information, NOT resist, ION bombardment. *See below Aluminizing Preparation, also, the power of concentrated, controlled IONS.*

**Note:** Later on, a thin coating of aluminum applied in front of the Phosphor Screen, 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 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 (while the Electrons went along for the ride), but none-the-less, they caused the screen to light up (fluoresce) even brighter, than that of Electrons alone, for any given amount of particles [generally referred to as Electron Stream]. (See "Aluminizing" below).

The Electron/ION pinpoint Stream, initially has the power to penetrate the aluminum layer, going forward, but NOT have enough force, 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, and opposite the coated side, of the Cathode Cylinder. These coatings, (stimulated by the intense heat of the Filament {800 Degrees C, 1,472 Degrees F and upwards}. And upwards, because in the conversion and activation of the Cathode Coating, voltages, as high as 13 1/2 Volts, are applied to the filament. Then, via instructions from the set-up, of the T.V., obeying directions from the Televising source, the Cathode Coating, through the G1 assembly, releases 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. SEE testing, later on herein, for the characteristic, known as, "Cut-off". This is how the picture may depict White and all shades of Gray, eventually to Black, [lack of Electrons impacting the Phosphor Coating].

Generally there is a combination of Three (3) materials, containing many diverse Ions, which are deposited on the flat, top-side of the round metallic cylinder, (CATHODE), which is 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 f(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 Three (3) sheets of 20 lb Paper}, was deposited on the flat, outer top-surface of the Cathode Cylinder, (which contained the heating element, the "Filament").

**NOTE:** That tiny amount of Cathode coating, (theoretically), could produce enough Electrons for the CRT, for over 100 years. The combined coatings, generally consisted of the chemicals, Calcium, Barium and Cesium.

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 in the Nineteen-Fifties, the varying amount of Electrons, increased/decreased, the Color of the impacted Phosphor, (INTENSITY).

According to ONE (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 Four (4) times BETTER picture than the U.S. 525 line system. See EXPLANATION, of Double-Quadruple principle NEXT.

EXPLANATION: of "Double-Quadruple Principal". 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, [Principle,] 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 One Thousand Watts of electricity in a 7 mile an hour wind. If you increase the wind speed to 14 MPH the same windmill will produce (4) Thousand 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 then produce 4,000 Watts of electricity in the 7 MPH wind. Now if you do both upgrades at once, (double the wind speed AND double the blade diameter), you now will produce (16) Thousand Watts of Electricity, in the (6) foot Wind-Blade, in the 14 MPH wind).

See cifaldi, carmine in GOOGLE, relative to Patent #6,372,978 B1, [4-16-2002]. It discloses complete details, of an Hybrid Solar Heating System, with extended Storage Capability. It uses the Sun and the Wind, as the sources for generating heat, through what is commonly termed, "Renewable-Energy" Sources.

Most of the information herein relative to "Electron Guns" has reference to those "GUNS" used for presentation in 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, as One unit in a triangular configuration. The single unit, comprised of the (3) gun arrangement, 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 Tube contains **(3)**, Phosphors, deposited on the face of the CRT, in the form of minute dots, EACH, DOT BEING, all **RED**, OR all **BLUE** OR all **GREEN**, only. They are also arranged in a triangular configuration. For a **25"** color tube, there are approximately **333,000** dots of Phosphor, of each Color.

The Electron guns, situated in **TRIANGULAR** array, in the far end of the neck of the CRT, are positioned such, that Electrons emanating from the **"RED"** gun could impinge **ONLY** the 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 is fixed in place, a short distance in front of the Color Dots of Phosphor, the {**TRI-COLOR**} **SCREEN**. It is 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** impact the Red, **NOR** the **Blue** Phosphor Dots.

Later advanced models Color CRTs, with a different arrangement, consisted of **BANDS** (strips ), of the Three colors (in vertical array). The extremely fine portions of all **(3)** color Bands were bounded {by dark Blue bands, in the Horizontal Axis}. The Bands of **TRI-Color** bits, likewise were used to achieve all colors and Thousands of variations, which 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}:

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 30,000 Volts**.

Electron Guns, operating at higher than **25,000 Volts**, required **"WARNING-LABELS"**, of possible radiation side-effects.

**NOTE:** The Warning Label recommendation was, that there should be at least Three **(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 LAW"**, (as you double the Distance away from an X-ray source, Radiation, in Roentgens {Rads}, decreases by the Square of the Distance, in Centimeters).

At a meager **6.3** volts, A.C., drawing **600** milliamps of current, there was heat generated to approximately **800** degrees ( C ), or **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,(both types of signal control, were used), 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 ( Heater ), supplied the heat necessary to liberate Electrons/ Ions from the **(3)** coatings. TECHNICALLY, there was enough coating to supply Electrons/Ions for **(100 )** years. Some CRT's, were found to be still working, (with an acceptable picture), after **(50)** years

### **REPROCESSING OF USED CRT'S, or in, TUBES WHICH FAILED IN-PLANT**

Originally, (circa 1944), DUMONT T.V. sets, used a magnetically-deflected, electronically-focused "straight-gun", where the Electron/Ion beam was sent directly to the screen. Unfortunately, it was found, after a period of One (1) to Three (3) years, that the Straight Gun, produced a burn in the visible screen, which RESEMBLED the pattern, being broadcast by the T.V. Station. In 1946, television programming was only broadcast One (1) or Two (2 ) hours a day, in the New York, METROPOLITAN AREA), which included parts of New Jersey and Connecticut. At 5 P.M., on Ch 5, Allen B. Dumont, (WABD), showed "HOWDY-DOODIE", 5 days a week. But, none-the-less, some people left their T V. lit up all day, hoping to see whatever else MIGHT be broadcast (hence the signal being bombarded/burned 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.,so they always left their T.V. sets turned on, Ten (10) to Fifteen (15) hours a day. 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. It would now NEVER disappear, even when normal video information was only meant to be seen. This obviously, was un-acceptably ever-present, on the Phosphor Screen 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, continued to suffer that annoying effect, because, replacing the CRT was the most expensive part in the T.V. Set.

**NOTE:** Even when that burned-screen tube was returned 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 then the Bulb would thereby be useless. That is one of the reasons, we have "Screen Savers" today. But, "Straight" Electron Guns, EVENTUALLY were/are, the ones of choice, with the advent of perfection of the Aluminizing process/techniques.

**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 though, 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 WABD pattern nor the Skull and Crossbones defect, visible. Of course, you now also need a new Electron Gun and all the materials and work needed to fabricate a working CRT. The end result of this process, came to be known as a "Rebuilt Picture Tube". It not only cost much less money, but many times, it contained an upgraded (more modern), Electron Gun and the use of newer, better, Phosphors. Thereby it actually produced a SUPERIOR picture, than that provided originally. That Rebuilding process, also conserved raw materials AND energy, and at a price, more people could AFFORD.

**NOTE:** Rebuilt picture Tubes needed 2 additional steps, in its manufacture. The FIRST, ("RE-NECKING") was, cutting the neck of the (under-vacuum, of the used CRT). A new piece had to be added, so that the CRT may then go through the manufacturing process. This was done on a GLASS LATHE. The Glass Lathe had a "HEAD", which could hold the Tube firmly in place, while rotating. On the other end of that lathe bed, was a much smaller heard (resembling) a three-jawed unit, (spring- loaded), which held the new neck, to be sealed into the CRT. This jawed head, also revolved at the same speed, as the Head end (holding the Bulb).

Underneath the neck area, there was a series of Gas Jets, (8 to 10 in number), dependent on the model of the lathe), arrayed in a gentle, u-shaped, upward setting. This series of jets had access to Oxygen and Illuminating Gas and/or Oxygen and Hydrogen Gas, [Oxy/Hydro], (as needed). The Oxy/Hydro, was NEEDED, when glass work had to be done on the Bulb proper, because it was a different type of Glass, than the neck, which required a hotter working temperature, than that which could be achieved by the Illuminating-gas/oxygen combination. The Glass neck itself, was composed of "lead glass", which could

be worked at a much lower temperature, that that, of the BULB proper), Therefore, it was much easier to work with, at the lathe and at a later to be performed, Sealing-in process, of the Electron Gun. The inside atmosphere of the Bulb proper and the neck, had access to a mild stream of air,(upon command from the lathe operator), so as to counteract the driving force of the Gas-fired Jets, when the Glass of each, Bulb and new neck, was melted together.

NOTE: An important part of the "RE-NECKING" operation, was a BUNSEN BURNER. This was used to pre-heat the glass, that was to be heated, melted and for cooling (annealing), after the high temperature work was done. The u-shaped setup-up of gas jets were also available to pre-heat and/or anneal, but was not of much use, when working on the BULB proper.

The Second step, was to remove all labels and coatings (Aquadag-like), present on the OUTSIDE of the glass Bulb. This was generally done by "STRIPPER", designed specifically to emulsify, or otherwise remove the coating from the outside of the Glass Bulb. It was then rinsed off, with clean City water. The inside of the bulb was also washed, (to get rid of all the material previously used to manufacture the original), with a weak mild acid, such as Ammonia Hydroxide. When the Bulb, finally resembled that, of a brand new Bulb (Blank), it was then sent to the Screening Room, to be processed with other like-bulbs, as well as the brand new Bulbs. (See Actual Screening Process, later herein).

### **BENT ELECTRON GUNS AND ION-TRAPS**

A

very important Electron Gun UPGRADE, for "Straight-gun" Tubes, as the replacement Tube, was the "Bent Gun", which allowed few, if any Ions to bombard the Phosphor Screen. The "Straight gun", went out of favor, because the Bent Gun was designed so that the Electrons and Ions, which were generated, were separated, and MOST of the Ions, were NOT permitted, to impact the Phosphor Screen. 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, to allow the stream to impinge on the Phosphor Screen. The separation device, called an "Ion-Trap", allowed the Electron Stream (only), to proceed to its assigned task. The Ion-trap was a spring-loaded permanent magnet, which fit around the outside neck of the CRT,(like a ring on a finger), that when rotated/aligned properly, allowed only the Electrons to provide the received broadcast, video instructions. For a while Straight Guns were out of favor. 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 an "Electron Beam Bender", because basically it did NOT trap Ions, but it had that effect. Because both Ions and Electrons, emanated from the Cathode coating in a straight line, neither could be sent to directly to impact the Phosphor Screen, because of the purposeful mis-alignment of the Gun structure. The Ion Trap Magnetic field interceded, by bending the Electrons in the stream, so that THEY COULD be directed into the Phosphor Screen. The ION-TRAP was of sufficient strength to, and DID, influence the Electrons, but Ions which were, THOUSANDS

of times heavier, than an Electron, were less affected. Therefore, the stream of Electrons, was bent by the magnetic field of the Ion-trap, and transmitted the video information, onto the screen. The IONS were generally allowed to dissipate, harmlessly. However, there was at least one exception to this rule, in the Author's personal knowledge, (See EXCEPTION later herein).

**EXPLANATION:** of Ion-Trap's limited ability.

Since the Electrons generated, contained an electrical charge (negative), they were influenced (bent) by the permanent magnet, and allowed to be collected, shaped, {focused}, propelled, so as to impact the Phosphor Screen. As long as the Ion-Trap, was properly arranged/positioned on the neck of the CRT, it retarded tremendously, if NOT, stopped the screen Ion Burning. The much HEAVIER Ions, whether Positive or Negative, (even though both contain electrical charges), {although most IONS, derived from the Cathode-material composition, WERE negative), such was irrelevant. BOTH Positive and Negative Ions, were LITTLE-effected, by the limited strength, of the Ion-Trap Magnetic Field. In the main), they COULD NOT/DID-NOT, impact the Phosphor Screen.

The author feels that there is an analogy here, between a "BLACK HOLE", as proposed by STEPHEN HAWKING, that some light particles may escape the Black-hole, {HAWKING RADIATION) because of their location around the periphery of the Black-hole. In that regard, by the same reasoning, there probably ARE some Ions, (because of THEIR location), which ARE able to impact the Phosphor Screen. They would be only slightly affected by the weak magnetic field of the Ion-trap but some Ions, could impact the Phosphor Screen. (See CROSSOVER-POINT, LATER HEREIN). The much stronger Magnetic Field, generated by the Focus Coil, CAN EASILY handle the IONS. Because of their much heavier weight (THOUSANDS of Times heavier than the Electrons), compounded by that fact that their speed, [see Herman Minkowski and Einstein below], increased their weight by 200 times, added their contribution, to the penetration of the Aluminum Coating. The brightness achieved, (certainly NOT, minimal), was evident. The combined Electron/Ion Stream is a potentially destructive source of energy. (Remember, the hint, of Phosphor Screen, AND, Glass burns, which ultimately led to ("Screen Savers")

### **"EXCEPTION"**

The "Trapped" IONS, usually continue to rattle around in the Electron-Gun structure, until they are finally dissipated and do NOT effect the desired result. 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, but instead, to actually concentrate and blast a circular hole, in the Anode Electrode, of the Electron Gun, (about the size of half a #2 Pencil eraser). NOTE: JUST LIKE BUCK ROGERS OR FLASH GORDON, A HAND-CARRIED PISTOL-LIKE WEAPON, THEY CALLED A "BLASTER", or a RAY-GUN! NOTE: The "Ion-Trap" magnet system, was discontinued, and since the 1970's, is NO longer being used.

Later on, it was accepted by the Scientific Community that Electrons, DO have some weight, {trillionths of a gram ?}, (454 grams to the lb ; 28.375 Grams to the ounce). Traveling in the vacuum, at near the speed of light, the Electron stream, impacts the T.V. Phosphor screen AND causes TINY PARTICLES of phosphor to fluoresce, {"light up"}. This is accomplished, according to instructions, as coded, from the sending source, via the Electron Gun. Even though, the Electrons are virtually weightless, according to MR. Hermann MINKOWSKI, {one of Einstein's Professors}, (they do have some mass). He had rightly suggested, that "SPEED INCREASES MASS"). Neither man, suspected that the Electron DID have mass.

Later on, as EINSTEIN (1879 to 1955) 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. "EXPLANATION", of Speed increasing Mass: Since more electrons are NOT added, to a single Electron, then the extra mass, (weight), must come from something/somewhere else. It comes from the Energy, (called Kinetic energy), put in, to get the Electron, (or any particle/mass), to move that fast.

The Kinetic Energy, is therefore added to the Energy, of the Electron at rest. Then therefore, since  $E = M C^2$ , {in which Mass can be converted to energy and Energy can be converted to mass}, then, the Electron, or Ion, or ANY particle, WILL get heavier, because of the Energy put into it, to make it go that fast.

Therefore, since the Electron Beam proceeds at, or near, the speed of light, its impact, causes the selected portion of the impacted particles of Phosphor to light up, {Fluoresce, in terms of DECAY TIME}, momentarily. That effect, (on a particular particle of Phosphor, was later defined as a "PIXEL", [Picture Element]. FOR MORE INFORMATION ON "PHOSPHOR", and "DECAY TIME", see Sections LATER HEREIN, labeled "PHOSPHOR" and "DECAY TIME".

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, which are to be impacted. The "down-sizing", (reduction of the diameter), of the Electron Beam, enables the production of a finer, MORE lifelike, picture, (which is characterized as "DEFINITION").

HDTV achieves excellent Definition, because of related circuitry, which provides information on 1,080 HORIZONTAL lines, instead of 525 HORIZONTAL lines. This means more/smaller detail may be shown because it breaks the picture into more parts. Therefore, (4 ) times as much information is able to be displayed, by HDTV, than the 525-line system, as dictated by the "DOUBLE-QUADRUPLE LAW".

NOTE: The combined, (increased) mass of Electrons/Ions, propelled at such a velocity, may easily penetrate the aluminum, impinge on and light up, the phosphor particles. However they do not contain enough energy, to reverse course and re-penetrate, out, the Aluminum shield, back towards the Electron gun. Additionally, the Aluminum cover, which is bright

and shiny, additionally functions, as a reflector. Therefore all (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. The Phosphor used in Black and White Picture Tubes, is called " P4 ", and is of Medium Persistence, and the Phosphor, which is yellow, tends to favor a faint bluish caste. The preferred Phosphor, to be used in Special Purpose Tubes, for direct photographic purposes, was a P1 type. It also was a medium persistence phosphor. The Phosphors used in Color Tubes (P31), [Red, Blue and Green], are also of Medium Persistence. There are 3 small {5"} CRT's contained in projection T.V. Sets. Each of them, are composed of One color, [their own], ONLY, covering the whole face, of each CRT.

## **"DECAY TIME"**

"Decay Time" is

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. For example: for a Radar Tube, you wanted a phosphor with a long persistence. You didn't want the blips, {which do represent a rather large airplane}, to disappear, or blink on and off, (unless the program called on it to do so).

But, for a Child's Arcade-like Game, you want a phosphor with an extremely short persistence, (much like a "REFRESH RATE" ABILITY), as 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, (INCREASING OR DIMINUTION), of another.

NOTE: Phosphors, are tested for Decay-time, but such process can also be called PERSISTENCE. Phosphors, also come in different tints/colors. The combination generally used for a Black & White Picture Tubes is a "P4" Phosphor, which 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 1" Phosphor. That was because the EXPERTS doing the filming, determined that the Greenish Tint hue, 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).

## **SWEEP CIRCUITS**

“Sweep” circuits, provided by an external device surrounding the neck, [called a YOKE,] are responsible for “DEFLECTION”, {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 D T V ), 525 lines of video information, per second, is produced onto the screen. (more later ). In certain tubes, such as Oscilloscope tubes, [Sweep-circuits,] DEFLECTION, is created by electrodes, attached to the Electron Gun itself (internally). That type of Gun was known as an “Electrostatic-Deflection Type”.

## **[INTERLACED SCANNING, 525 HORIZONTAL LINES OF INFORMATION**

The American Television system was based on the SWEEP Circuits providing 525 lines of Horizontal information, via a system called “INTER-LACED” scanning”. This was controlled by the Horizontal frequency of 16,750 Cycles (now Hertz), per second, which drew pictures, based on the following procedure: First, 262½ ODD lines of information were transmitted/received. Then, 262 1/2 EVEN lines, of information had the same thing done. Both, the Even and the Odd numbered displays, were then joined together, (by the eye and the persistence of the Phosphor particle(s), and called a FRAME, which each was repeated twice, making a total of Sixty (60) Frames per second.

Sixty (60) frames a second corresponded with Sixty (60) Cycle Alternating Current, in the U.S., 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, (called DECAY TIME), fools the eyes into seeing a complete image (“SNAPSHOT”), thus producing a full completed moving picture, in “real time”.

COMPUTER uses, favor “PROGRESSIVE SCANNING”, (transmitting of information of the Horizontal, 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 associated part of the YOKE). The gun was designed so as to be able to separate Electrons from Ions. Both, are generated/liberated from the “Cathode COATING, (generally a combination of Calcium/Barium/Strontium or Cesium Oxides).

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

1. Turning on T.V. Set Applies Voltage to 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 14,000 Volts to the anode ..... (Floor Accelerator to achieve top Speed)
6. Electrons light up Phosphor coating ..... (Ability to see the destination)

## **MANEUVERING, SHAPING, THE ELECTRON STREAM (BEAM), “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” of Electrons and are accelerated through the round hole (aperture) of G 1. Now comes the hard part to envision:

### **FOCUS ACHIEVEMENT**

First, let’s get rid of the Ions. A “Bent-gun” is so aligned, that NO Ions, NOR Electrons can impact the Phosphor Coating, because of the Electron-Gun’s, purposeful mis-alignment. An externally-mounted permanent magnet, (called an ION TRAP ), spring-loaded, fits 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 2 aperture. The electrons, ARE, easily influenced by the limited strength, produced by the Ion-Trap’s magnetic field. Almost all the IONS generated/released by the Cathode Coating are NOT able to be bent by that weak magnetic field, generated by the ION-Trap, because they are more than 2,000 times, more massive (heavier), or more, than the Electrons. NOTE: Some Ions may be EVEN 10,000 times more massive than the Electrons, {ALL Electrons, negative or positive (Positrons) have the SAME weight} Therefore most Ions cannot access the G 2 aperture (hence, the name “ION-TRAP”). Having said that, some IONS do access the G 2 aperture, because they emanate from the peripheral areas of the cathode coating. The few Ions which do evade capture by the Ion-Trap, proceed alongwith the Electrons. Later, in their journey Ions, are easily handled, by the more powerful magnetic field(s), generated by the SWEEP-CIRCUITS AND the FOCUS COIL, whether internal or external.

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, ever-narrowing a funnel-like shape, until it reaches into 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, is called the “CROSS-OVER POINT”) and again, 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, into the desired focus achievement, EXACTLY AT THE POINT OF IMPACT OF THE PHOSPHOR SCREEN.

The Focus Coil, for use with a BENT-GUN, is mounted on the outside of the neck, adjacent to, and immediately to the rear of, part, of the “YOKE” assembly. The YOKE sees/controls, the ENTIRE COLLECTION OF the ELECTRONS (STREAM), and by various voltage signals [creating varying strength magnetic fields], move the Electron Stream, Left or Right, Up or Down, with the Stream being treated as One complete part. ( See more of “YOKE”, later 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 Coil’s strong magnetic field, the Electron Stream is heading to impact the Phosphor, while also trying to achieve a 2nd Crossover. 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, (attempting a 3rd Cross-over, by the time it hits the phosphor Screen, making a large, [silver-dollar size], dot stream of Electrons).

But, with the proper Focus Voltage applied, the Pinpoint Dot of the Electron Stream, lands EXACTLY at the Phosphor Particle DEPOSITION. Therefore the Electron Stream is STOPPED from effecting the 3rd Crossover, (PERFECT FOCUS). The smallest pinpoint Electron Stream is 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 to start 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. The Pin-point stream, will be deflected up or down or left or right of where it is supposed to go. Due to the decay time involved, you will then see an AVERAGE, of all those points, hence BLURRY. The more Gas Molecules present, the more collisions, the even more BLURRY the picture.

**HIGH DEFINITION TELEVISION (HDTV)**, HDTV is a **1,080** horizontal lines SYSTEM, promoted by the Japanese, which is becoming very popular in the U.S. (circa **2003**). Unknown by the Television Industry, a **1,050**-line System, Ultra High Definition (UHD), was actually INVENTED, constructed and used by an American, Carmine A. Cifaldi,, in his CRT-manufacturing company, in Paterson, New Jersey,(in **1956**). At a request from a Medical Facility in Philadelphia, he hand-crafted a special Purpose Electron Gun, (later, used as an integral part of his Patented, {**12/30/1999**}, Video Telephone System, entitled, **HIGH RESOLUTION OPTICAL COMMUNICATION SYSTEM**). He constructed a modified Electron Gun, in combination with, a special, high decay-speed, Green-tinted Phosphor, [**P1**], Special-purpose CRT.

**ULTRA HIGH DEFINITION SYSTEM (UHD)** Cifaldi’s ULTRA-HIGH DEFINITION (UHD) Electron Gun, was used in a CRT, which had a medium persistence Phosphor,(P1), [which has a greenish appearance]. It was meant to be used, in conjunction with, an high-quality, super-fast, Motion Picture Camera, which used High-speed film, to photograph directly, from the face of, the CRT. It recorded an actual, live, laproscopic gall-bladder-removal operation. The film was then used for future reference, and as a training tool, for teaching prospective/future surgeons, (especially for Third-world countries). That Electron gun/system, (see EXPLANATION, HOW UHD WAS ACCOMPLISHED and EXPLANATION of gun design below), was not patented, because the Television Industry was NOT able/ready to use it, (mainly because of “Bandwidth” constrictions, the way the signal was transmitted, through the air). However, HDTV is routinely credited today, as being of Japanese origin. Whatever the case, HDTV, when coupled with “Flat Panel” devices, using digitalization of signal. This produces pictures, rivaling, (even exceeding), the finest of photographs the day,(circa 2005).

#### **[HOW UHD WAS ACCOMPLISHED**

Note: Because, the **1,050**-line system, can produce a picture equal that of the **1,080 Japanese** system, it can also therefore display a **(4 )** times better picture, (finer detail), than the **525-line** system, as dictated by the “Double-Quadruple Law.” Further, NO extra equipment is needed by the home-viewer, because the necessary circuitry, will be already built into the T.V. Set

circuitry. Cifaldi's UHD system was achieved in **1956**, by using the **"INVERSE"** of the **Double-quadruple Principle**, in the following manner:

EXPLANATION as to how the **"Double-Quadruple"** Law/concept was used, to reach the desired result. Normally, the APERTURE, [hole] in Grid One (G 1), is approximately **40** Thousandths of an inch in diameter. Using an Electron Gun containing a G1 aperture of **(20,000** ths) of an inch, [**1/2** the diameter of the normal], has decreased the round, circular shape of the electron beam, **TWO (2)** times).

**EXAMPLE** of how **Double-Quadruple** was used: A **(1)** inch, (not the actual size), **CIRCULAR** electron beam, is now shrunk to a **1/2"** diameter beam. Therefore, it may create double the amount of horizontal lines of information, **plus** double the amount of data on each line. That is because of its ability to impact ever-smaller molecules of phosphor. The **1,050**-line system therefore, shows much finer detail.

That is exactly what the Medical people wanted,( in conjunction with, an easier-to-photograph, [in Black & White], {pre-color days}, [a **Green-tinted** (Phosphor) Screen (P1)]. They wanted to photograph a laparoscopic **Gall-bladder-removal** operation, directly from the face of the CRT. [That was pre-VCR/DVD time].

Full implementation of either the **1,080** or **1,050** 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 Bandwidth space. **EXCEPT**, BEGINNING IN THE **1980'S**, we **NOW** had wide-spread use of Digital signalization, being broadcast through Cable, [first, co-axial, then fiber-optics].

Satellites [for a fee,] also fed television through **"STREAMING"**, {converting data to a series of **1's** and **zeros**}. Such techniques projected beautiful reproduction of video information. Because of those advances in technology, the pictures being shown, [via **1,050**, lines] can, many times, often look far prettier/more realistic, than those in actual life. This includes the ability to modify the pictures, by removing blemishes, lightening-up some feature /darkening others; adding more/less color; even changing the tint or the color, etc.

### **STREAMING**

The use of **"STREAMING"**, encoding of **"DIGITAL SIGNALS"** (CODED AS A SERIES OF **0'S** AND **1's**), in that format, (are providing even finer, better detail. Digitizing signals are now allowing **PREVIOUSLY** un-allowed broadcasting signals to be broadcast,(equipped with conversion boxes), directly to television sets by the Satellite providers. Over-the-air, station broadcasting, as practiced in the early days of television, in the **1950's**, and still today by **RADIO**, is rarely used (circa **1990**). Television signals received from Satellites in Geo-synchronous orbit, with associated equipment, is yet an important viable use of transmission.

The Negative side, for that type of transmission is, that inclement weather conditions may interrupt signal receipt at any time. The receiving DISH must not become mis-aligned, resulting in total loss of signal. On the Plus side, the signals may be received, where there are **NO** Cable lines. With certain equipment, such as an **INVERTER**, [changes Direct Current into A.C.], (Alternating Current)], {as in your home}].

Coupled with the use of batteries, [like in your car], then **SOME** signals may **EVEN be received/used**, where **NO** Electricity, is available from traditional sources, where there is **NO** (Cable AND Electric line availability). One wire, of a regular electrical extension cord, serving as an Antenna will suffice, to bring those T.V. Station signals in, to the TV Set, which may receive air-borne signals [T,V.].

This is pursuant to an order, issued many years ago and **STILL** in force, [circa **2007**,] as mandated by the F T C}. **NOTE**: Starting in February **2010**, (projected), those signals will **NO** longer be broadcast over the air.

## **HOW THE TELEVISION PICTURE TUBE (CRT) IS MANUFACTURED**

### **Step (1) Preparing the Glass-Bulb (Tube) for Phosphor Acceptance:**

1. 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 and then rinsed with fresh, clean Tap-water (**10** to **15** seconds).
1. 1B It is then placed and **CLAMPED** on an hydraulically-operated "Tilt Table", which will be able to rotate smoothly, in a **240** degree arc, so as to not cause ripples when pouring a **SLURRY**, of **PHOSPHOR**, and **DISTILLED/DE-IONIZED** water, 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

## **PURE WATER, (mineral-free), REQUIRED FOR DEPOSITION OF PHOSPHOR, . IN PICTURE TUBES**

There are only **(2)** types of water acceptable, to be used, in the manufacturing process, (deposition of Phosphor on the inside face of the Tube). The best, of course, is **DISTILLED water**. The problem with that is, the cost of the amount of distilled water, to be used, is prohibitive. **All** of the water used, will be immediately discarded, after the Phosphor is dispersed. Having said that, there are times in the year, when distilled water is absolutely required, unless extraordinary steps are taken. **De-ionized water** problems, **EXPLANATION LATER** herein.

The other type is "**DE-IONIZED**" water. The initial problem with the use of **DE-IONIZED** water, is that it requires a substantial amount of capital, to purchase a **UNIT**. You need a

UNIT, capable of producing water, at the size commensurate with the amount of Tubes, expected to be manufactured, on a daily purpose. See UNIT composition, next.

One unit, consists of the following parts:

A. De-ionizer Machine.

B. At least a One Thousand Gallon Stainless-Steel, ( S. S. ) Storage Tank,

C. At least TWO, 250-400 Gallon, ( S. S. ) "BATCH" Tanks, (depending on production requirements).

D. An appropriate-sized, Rock/Sand/Activated-charcoal Filter.

E. A High-Volume Stainless Steel Water Filter.

F. A High-Volume Stainless-Steel Water Pump.

G. All the accessory Stainless-Steel and/or plastic piping, valves, fittings and hoses, relative thereto.

The **1,000** Gallon (S.S.) Tank, is the recipient, of the water being continually being De-ionized, and sent to it, for use, or for Storage, (whenever there is no screening taking place).

The 2 Batch Tanks, each receive a full tank of water, on command, to be used in the following manner: Since ALL dissolved metals/**ions**, have been removed, the Water has a **PH of 7.0 (neutral)**. **Above 7.0** the water is considered **ALKALINE**. **Below 7.0**, the water is considered **ACIDIC**. In preparation to receive the Phosphor, the water is conditioned in the following manner:

Add a gallon of water, containing an appropriate amount of Barium Acetate, (which assists the Potassium Silicate, [**KASIL**], which will be added to the Phosphor slurry later on). This assists the Phosphor, to adhere to the Glass face, done in the next step. Water, drawn from the first tank, will be used for the screening. The Barium is then allowed to be dispersed throughout the "**Batch Tank**", on its own, for at least half an hour.

If necessary, the disbursement may be accelerated, in the following manner. This is done by the use of a Stainless Steel Pump, drawing water from, and emptying back into, (Re-circulating), the S.S. Tank, for at least **(5)** minutes. While the water in the first Batch Tank, is being used, the other Batch Tank is made ready the same way, so IT, is ready for instant use.

When the first **Batch Tank** has been drained of all it's water, then the **2nd** is readily available and used. Then the First Batch Tank, is again filled, from the **1,000** Gallon Storage Tank, and made **READY**, yet, for another cycle.

There are (2) types of De-ionizers: The first, is a unit which has (4) Columns, which contain Resins to remove Dissolved Metals, both of the ANION and CATION variety, from the water being processed. The Columns are arranged, in sequential use; Anion-extraction Resins in the 1st and 3rd columns and Cation-extraction Resins in the 2nd and 4th columns.

There is an electrical resistance meter, which constantly measures the resistance of the water passing through. For water containing very little dissolved metals, the meter will show 2 Million Ohms, (or HIGHER), resistance. As the Resins ADSORB the dissolved metals, the Resistance Meter, keeps dropping lower and lower.

When the Meter shows around 50,000 Ohms, (showing better and better conductivity, which is NO good for our purposes, because as it shows more and more metals being extracted from the water), The adsorbing powers are badly diminished. At that point, it is time to get rid of the metals, that the Resins adsorbed, from the water passing through.

This is accomplished, by a process called "REGENERATION". Through the use of Muriatic Acid (in one set of columns, and Caustic Soda, in the other set of columns, the metals, which were "ADSORBED" (on the surface of the Resins), are stripped off, and flushed into the Sewer line. The DE-i is then ready to remove the dissolved metals, for another Cycle, (depending on the hardness of the water supply), for, from 100 to 150 Thousand gallons of water.

The regeneration process is always the same, in using both the Muriatic Acid and the Caustic Soda, and is pretty straight forward in the 4-Column DE i. It is trickier to accomplish in the MONO-BED DE-i. Therefore, we will only discuss the complete Regeneration process, of the second type of DE-i, the MONO-BED.

The Second type of De-i unit, is called a MONO-BED. This is a tall, (7) or more, feet high), about 18" in diameter, single column unit, (generally a High-Capacity feed-through, (200 gallons per hour, or more). It contains both Anion and Cation-extracting Resins, [called BEDS,] mixed together. There is a "porthole" window, in the side of the mono-bed, which enables you to see the Resins in the unit.

When it is working properly, in removing dissolved metals, you can see a homogeneous mix of light-brown Resins and dark-brown Resins. These resins NOT only look different, they also are of very different weights. This weight difference is for a very important reason. To regenerate the Resins, (when the Conductivity meter reads about 50,000 Ohms ), the Resins must first be separated, and stratified. The light color [tan], resins, [also lighter in weight], form the upper layer, above the lower layer, and also heavier, dark-colored [Brown] Resins.

**CAUTION:** Do NOT allow the conductivity to get too low, as that means the Resins are saturated, and the Resins lose the adsorbing characteristics. Water containing metals, will be in the processing where you then run the risk of poisoning the Phosphor Coating, [which will not be immediately seen]. You WILL see it, after an Oven-Baking process, but even then, it could NOT be seen with the naked eye. An Ultra-violet light would be needed, to make the Phosphor fluoresce, as it would be seen, when the Tube is under Vacuum and

being bombarded by the Electron Stream. If poison spots are detected at that time, then all that time, labor and effort are LOST, and you must re-wash the inside of the Bulb, and start all over again.

Normal water-flow operation, starts from the top of the Column, down through the Resins and then into the **1,000** Gallon S.S. Storage Tank. The Regeneration of the Resins, starts out with the separation of the Two Resins, done in the following manner: City water, at a controlled, reduced, water flow, is introduced into the DE-i, from the bottom of the unit, towards the top, (opposite normal operating-procedure).

The water will go up through the Resin Bed and out to the Sewer system, via a "Sight-drain". You can see and "**feel**" the water coming out of the De-i, as it enters the sight drain [water pouring out of a pipe, into a funnel like arrangement drain. Looking into the Porthole, and adjusting the water flow, you will see the lighter [Tan] Resins, start to separate from the mixed Bed, and "HOVER" (stratify), over the Brown [Resins], part of the bed.

When you start to see that happening, you must check the water emanating the DE-i, as it enters the sight drain. By putting your hand in the water-flow, and rubbing your thumb and forefinger together, you will be able to ascertain, whether any resins, (normally the lighter ones), are also being expelled from the unit. Since the lightly-colored, [Tan] resins, are also the lightest, they are not readily discerned, as being dis-charged from the outgoing water. The thumb-forefinger monitoring will "**see**", (**feel**), the resins emanating, [if any].

With careful monitoring,, of water pressure/flow, you can separate the two types of Resins and not discharge the Resins, out with the waste water. CAUTION: If you are not careful, you may lose the whole Bed, if the pressure/water-flow is too high. At that time, the Unit will have NO functionable ability.

The result is that, the unit must be put out of service, opened up and a new mix of Resins must be added. THIS IS COSTLY IN TERMS OF MONEY AND TIME. But, you do have some leeway, because of the Height of the Column, it takes more energy, for the Resins, to fight the effects of gravity, (which help keep the Resins, from being water-flowed out).

Sometimes you may lose ONLY the lighter Resins. Even then, you will still have to replace those, if you lose them. There is no easy way to replace the lost Resins. You must pull apart, (nuts, bolts, and gaskets), the Mono-bed Column.

Assuming you successfully separated the Bed, then through a series of valves and bypasses, Caustic Soda is introduced to strip the dissolved metals adsorbed of one of the separated Resin beds, without impinging on the other. Then Muriatic Acid, is introduced to strip the dissolved metals from the other bed (again, without impinging on the other Bed). This is accomplished by a clever arrangement of piping and valves, inherent with the construction of the **MONO-BED**.

When that is done, City water, is introduced, sequentially, from the top, to the bottom and out the Regular Sewer Drain. This flushes all acids and dissolved metals, into the Sewer system. Checking the Conductivity Meter, as the fresh water is flushing, will reveal that conductivity is heading back up to 1 Million Ohms. The water may be used, for Screening purposes, at any time when the meter rises up to 250,000 Ohms, even while it continues on the way up [to Millions of Ohms, resistance].

Now, to put the unit back into operation, first, you must RE-MIX the Bed. This is accomplished by water, directing the water-flow, rising from the bottom upward. It will be assisted by compressed air, on command by the operator. This will cause an agitated disturbance, through the bubbling-up of ALL resins, ( but by a valve arrangement, in a closed loop, so you can NOT lose any resins). You may continue this "merry-go-round" arrangement, until you attain the homogeneous Light/dark Bed, once again. The De-i is then ready for a new cycle.

Prior, to the water entering either De-i, it must first be particle-free of all solids and most organisms. With either type of "DE-I", water from the local Water Company starts its journey, through the Rock/Sand/Activated-Charcoal filter, where it filters out all solids, present in the water. (There are more than you think, or would like to know).

NOTE: Normal water-flow is from the top of the unit to the bottom. At the top you have a layer of rocks, (about the size of marbles). Below that, you may have another layer of stones, (about the size of peas). Then, comes a layer of Activated charcoal. Finally there comes a substantial amount of sand. Below the sand, you have a Screen filter (fine enough to NOT let the Sand escape, but porous enough to allow, an un-restrictive water flow)

The layer of Rocks, Stones and Sand, trap the largest particles first, then smaller particles, then even smaller particles yet. Activated-Charcoal, also neutralizes many different organisms, contained in the water, which will be removed, later, by the Stainless Steel Filter.

**NOTE:** Normal water flow is from the top of the Filter down through the mix, then to the next separate, (additional), S. S. Filter. You must flush out the solids, periodically, that the Rock/Sand/etc. Filter, has trapped. This is commonly called "BACK-WASHING". You do this, by reversing the water flow, (AGAIN THROUGH A SERIES OF VALVES AND PIPING), with the water coming from the bottom of the unit, through the top of the unit, and then, out to the Sewer drain.

On to the S.S. filter. This filter has the ability to trap all particles AND organisms, down to 1 Micron in size. NOTE: In the summer time, during the Hot weather, algae and other micro-organisms proliferate. By use of a material called "filter-aid", the S.S. filter may the trap particles as small as One Tenth of a Micron.

Finally, from the S.S. Filter, the water is directed into the **1,000** Gallon S.S. Storage Tank. From there it is released into the Batch Tank, (as needed). The Two Batch Tanks, are

serviced by **(1)** Stainless Steel Pump, through a series of piping and valving, which allows water to be drawn from either tank, on command.

**EXPLANATION:** As stated earlier, De-ionized Water problems, **FORCE EXTRAORDINARY METHODS TO BE USED.**

Earlier herein, it was stated that, during certain times of the year, (extended warm-climate periods), the Distilled water **HAD** to be used. That is because of an abnormally high Bacteria count, coupled with insufficient Chlorine treatment by the Water Company, supplying City water. It has overwhelmed the filtering capacity, of the DE-i UNIT. Myriads of the **"BUGS,"** are killed in the DE-i unit, and their remains, degenerate into a non-soluble oil.

When the Water containing them, is introduced into the Tube for screening, the dead organism's remains, form protective bubbles around themselves. After the Tube is screened and the Phosphor is properly introduced, it is time for "DECANTING", (POURING THE WATER OUT OF THE TUBE). The bubbles, formed at the water line, drag lines through the Phosphor, to an un-acceptable level, in the finished product, thereby resulting in the necessity of washing out the unacceptable screen, to try again.

There are **(2)** possible cures for such a problem. The first, is to use a WATER-Softener, added with an **"eye-dropper"**, directly into the bulb, after the slurry is introduced. This will dissolve bubbles with air in them. Sometimes, it will also dissolve the Bug's protective bubbles, but sometimes it **will NOT**. Those bubbles, {unlike bubbles normally found in water}, have very little air in them, because they are tightly wrapped around, the dead organism.

The **2nd** solution ALWAYS works, but it involves an extra step, "PUMPING", using vacuum, EQUIPMENT and extra labor. However, assuming you have **(10)** Tubes on the Screening table, they may **ALL** be connected together, via a **2"** diameter metal manifold to the Vacuum pump. From the manifold, this High-Vacuum rubber hosing, [**3" in** diameter], is jammed into the neck(s) of every tube, connecting the Tube(s), to the Vacuum Pump. When the mechanical vacuum pump is turned on, in about **(3)** minutes, enough air has been evacuated from the system, that the air pressure diminishes, very rapidly, [reluctantly].

The Bubbles, (even with minute particles of air), will be seen to get larger and larger, (as they resist being ruptured), but, then they **ALL burst**, leaving the water, bubble-free. At that point, when the settling time of the Phosphor is completed, the connections between the Vacuum Pump and the Tubes, are dis-connected. Then, the tubes may be safely decanted.

### **ACTUAL SCREENING PROCESS**

**INTRODUCE WATER IN THE BULB TO A THICKNESS OF 3 to 4 INCHES.**

1. 1 (1) to (3) gallons, (depending on size), of pure De-ionized or Distilled water, (containing the 1/10 th % Barium Acetate reagent), is introduced into the bulb. Next, to start the actual screening process, a water/phosphor slurry, is introduced, from a shower-like dispensing piece of hand-held equipment, called a **“THISTLE-TUBE”** (described later herein).

**INTRODUCE PHOSPHOR SLURRY INTO BULB, USING THE THISTLE TUBE**The amount of phosphor 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. A PHOSPHOR SLURRY composed of Water, Phosphor AND Potassium Chloride, may dispense anywhere between (300) and (7) Hundred Cubic Centimeters (C C 's), [relative to tube size].

The Potassium Chloride, {alongwith the Barium Acetate, previously put into the Batch Tank}, are combined. This will aid in the distribution of the phosphor-settling procedure. The Potassium Silicate also assists in uniform distribution of the Phosphor, by preventing "CLUMPING" of Phosphor particles, as well as "Pin-holing," [as the name implies: small open areas, of NO phosphor coating].

Note: An Electron Beam, can NOT portray video information, where there is NO phosphor. More importantly, the Potassium Silicate acts like a "glue", to help the Phosphor particles adhere to the glass face, when the water is being poured out of the bulb, and when it is dried. Without the addition of the (2) chemicals, (Barium Acetate & Potassium Silicate), or even a poor ratio of one to the other, 90 % of the phosphor would exit the Bulb, when the water/slurry is pouring out, after the allotted SETTLING time.

A Thistle-Tube, consists of a ( 3 ) inch I. D., funnel-like top, about ( 4 ) inches high, which also has a (15 ) inch long, hollow, plastic tube, that has a, 1/2 inch INNER diameter. At the bottom end of the tube is a THIMBLE-like Cap, which has (15 )or ( 20 ) holes, uniformly distributed in all sides, with (4) angled outward holes, ( North; East; South; & West), in the rounded convex bottom of the Thimble-Cap.

### **PHOSPHOR DEPOSITS ON INNER FACE OF TUBE:**

The Phosphor slurry, is poured into the top of the funnel, drops down the long 15" Plastic pipe and exits the Thimble-Cap end, which thereby disperses the Slurry, much like a shower head. While the Slurry is pouring out, the entire Thistle-tube is rotated, continually, 360 degrees, until emptied, so 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 inner-side of the glass face.

To aid a uniform deposition of the Phosphor on the Glass, a stream of hot water, is directed ( by a hose), on the outside of the Bulb, (where the waterline is). The difference in Temperature, between the water in the bulb AND the outside periphery of the Bulb, sets up **CONVECTION CURRENTS**.

This would assist the Phosphor to be deposited evenly on the face, (as opposed to a heavy concentration in the center, and much lighter edges). When Settling is completed, it leaves an almost perfectly clear solution, with the Phosphor lying down on the inner face of the Tube. The Settling time is (10) minutes.

Then the table is slowly, evenly tilted, (Tilt-Table 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.

To be absolutely certain that air-intake and water outflow, can both be accommodated, do the following: Get a 1/2" I.D. plastic or polyethylene tubing about 14" in length, warm in hot water, until it becomes pliable, Bend it in a 1/2 "U" shape, and pour or douse cold water through it, and it will retain THAT shape.

When the Slurry has finished being introduced, insert the bent plastic/polyethylene tubing in the neck of the Bulb, such that both ends will point in the "UP" direction when the table has been decanted 90 Degrees. No matter how fast the water pours out, there is absolutely NO chance, for any screen-disturbing gurgles, to occur.

Total elapsed Phosphor-coating time, including “settling” time, is about (13) minutes, for a table-Load of (8) to (10 ) Bulbs.

### **FORCED-AIR DRYING OF NEWLY-DEPOSITED PHOSPHOR COATING/SCREEN**

1 2 When ALL water has left the Bulb, leaving it completely empty, un-clamp 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).

**NOTE:** 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, [NOT in the neck]. The Screen-dry time takes about (10) Minutes.

### **PREPARING SCREEN FOR LACQUER DEPOSITION FOR THE ALUMINIZING PROCESS:**

1 3 Remove the Bulb from the Dryer, and gently, lay the Tube on its side. While 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 1/2“ long), with a solution containing distilled or de-ionized water. The solution contains a 3 % Potassium Chloride addition, [the Phosphor-binding/anti clumping chemical].

2. When re-wetting, care should be taken, NOT to pour the solution directly on the Phosphor Screen. Let it be started, to be poured, into a side of the tube, and then, when there is about 250 CC's poured in, lift the tube and swirl the water all over the Phosphor face, re-wetting the entire Screen. 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 discernible in the initial stages of manufacture, but after baking (a later step), you will see round colored spots, [even though this is a black and white screen (tube)], appearing all over the screen. These colored spots, would ALWAYS be seen and therefore unacceptable to the viewer). Next: Allow the Tube to drain, momentarily, and then place the tube on a piece of equipment, which may rotate the Tube.

The centrifugal force generated will even out any excess water remaining on the face. Place the Tube on a 'Screen-dryer", and dry the screen. After baking, an Ultra Violet shining on the tube face, (in broad daylight, would make the screen light up) {fluoresce}, as if it were being impacted by the Electron Beam while under vacuum. **Green spots**, (like measles), would indicate **COPPER** contamination, **Brass spots** show as **Blue**, whereas **Purple-colored spot** will indicate **IRON** contamination.

If the bulb is allowed to continue to completion, eventually, when video information is displayed, **Green**, **Purple** and **Blue** spots, (in stationary positions), in **ALL** White display scenes, would make the picture(s) un-acceptable. This would be much like Station identification burns/skull and crossbones burns that were the bane of the old Straight-Gun, non aluminized, Black and White Dumont Television Tubes, (circa **1945**). **Except**, this time, the color spots will show up in Black And White, Picture Tubes.

### **APPLICATION OF LACQUER COATING:**

Again, re-wet the just dried screen, (as we just did), but this time, introduce WATER, with a **(20 %)** Percent **(30 %)** mix, of a fine polymer lacquer, and a **(10 %)** Potassium Chloride, gently onto the same Screen. Allow to drip for **(1)** minute. Place the newly-lacquered Bulb on a spinning machine {at **(30 )** RPM}. The centrifugal force, as before, generated, causes the lacquer to spread evenly, over the entire screen area. Elapsed time about **(3)** minutes.

### **WASH AWAY LACQUER IN ALL AREAS OF THE INSIDE OF THE BULB, EXCEPT THE SCREEN:**

1 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}, and **MUST BE DONE**

1. [temporarily]. Place the neck of CRT around a flexibly-curved, [**1/2** U-shaped], plastic pipe on another spinning, [**6** RPM] machine, which dispenses water in a fine non-splashing stream of water.
2. This will wash out, trim, away) all lacquer and water, from the interior of the bulb (while spinning), **EXCEPT** the Phosphor Screen. Start the washing at the interior of

the bulb, (while revolving), beginning at about Three (3) inches from the top inside face, 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" or "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.

NOTE, 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 prevented their release.

They called this process "**re-activation**" or "**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, deposited thereon, from other sources. The terrific positive end-result was because of the way the Reactivation device worked.

'Here IS THE SECRET:' 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/vaporized, the unwanted coating, away. Because that process also created a great amount of heat, the resultant was observed immediately. Remember, Electrons are generated from the Cathode Coating, by the heat, (800 Degrees C), supplied by the filament.

### **RE-DRY THE WET LACQUERED SCREEN:**

1 5 Put the mostly lacquer-free Bulb back on the dryer and dry everything, once again. Elapsed time, about (10) minutes.

### **COAT THE INSIDE WITH AN HIGHLY-ELECTRIC, CONDUCTIVE COATING**

1 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 the operator desires. 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.

2. Make sure that the coating touches, and completely contacts/ surrounds, the Anode button, (the metal anode button fused into the bulb). That metal button, is common to the **INSIDE** of the tube, as well as to the **OUTSIDE**. Ultimately, it will become the path for High Voltage to come into the Electron Gun).

It may be "**PAINTED**", with hand-brush-applying strokes, (throughout the entire bulb), or by spinning the bulb, while holding the brush still. The spinning-machine action, causes the paint to be spread, uniformly, throughout the whole inside. Spinning and painting round Tubes is **NO problem**. Rectangular tubes are a bit more tricky to so do.

**NOTE:** Take care, that the coating does **NOT splash**/impact, from the brush), onto the Phosphor Screen. Elapsed time to achieve painting about, **(3)** minutes. Dry the inside again

1. 7 Place the Bulb neck, around another low-speed-air Screen Dryer, to dry the conductive coating painting. Time to dry Dixonac coating about **(7)** minutes.

### **PLACE TUBE UNDER VACUUM TO APPLY ALUMINUM OVER THE WHOLE INSIDE OF THE BULB**

1. 8 **ALUMINIZING PROCESS:** 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 neck, joins the bulb proper). That confirms that the Tube is tightly enclosed in the machine, so 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, (much like the filament in a light bulb), which is in a horizontal alignment.

### **Starting-up the Aluminizing Machine**

- 2 A Vacuum Pump (part of the machine/operation), draws a vacuum on the enclosed system, including the CRT.

### **VAPORIZE ALUMINUM SLUG, WHICH DEPOSITS THE ALUMINUM, THROUGHOUT THE ENTIRE INTERIOR.**

When the Vacuum is completed, on command, the tungsten coil, (at **12** to **14** Volts), dispensing between **45** to **60** Amps of electricity, causes the aluminum slug (pellet), to slowly melt into a liquid ball. It then finally disburse, (like a cloud of steam), until the whole slug of aluminum has been evaporated from the coil, (also called "**SPUTTERING**").

The resultant cloud of Aluminum particles would then condense/solidify, thereby attached, uniformly, (SEE **EXCEPT** BELOW), over the entire inside of the Bulb, (including the Phosphor Screen AND the Aquadag conductive coating). Elapsed time about **(20)** Minutes.

Some systems may be able to draw a Vacuum on as many as **6** tubes, at a time, in

any given instance. But, they are **"SPUTTERED"**, sequentially, thereby effectuating the process, in as little as **30** minutes, [**5** minutes per tube].

**EXCEPT:** In instances of poor vacuum-achievement, (at any time, for any reason), then in that case(s), the aluminization results in a heavy deposition, [in the form of a **BULLS-EYE**], in the center of the screen, with much less of an ALUMINUM deposition, around the periphery. The poor vacuum attained, may be because of improper seating/sealing of the bulb into the unit, or because the process is timer-controlled, {ready or not, here I come}.

This may occur as different tube sizes are processed, and the timer is **NOT adjusted** accordingly. Or perhaps, **NOT under** direct command of an operator, OR even because, it **WAS** under operator command, and he made an error. Sometimes, [depending on the system used], when the sputtering is NOT controlled by a gas-pressure device, [or for many other reasons], when the vacuum is **NOT low enough**, the resultant will be poor.

Unfortunately, this result will **NOT be seen**, until the CRT is fully processed and at one of the final stages of manufacturing-**"TESTING"**. Few test regimes, plan for detecting this problem, and most CRT manufacturers **never detected** it, until it was returned from the consumer. SEE **"BLANK-OFF"**, in **TESTING**. See **HYPOTHESIS** next. In fact, this author is the only person/manufacturer known, [including **ALL** the well-known major manufacturers, such as RCA, Sylvania, GE], ever, even testing, for it.

The **HYPOTHESIS** for this anomaly is as follows: When the filament in the unit is activated, the tremendous amount of heat generated, forces all gasses, [developed or residual], to compress those gasses, in an equal diameter, in **ALL DIRECTIONS**, to the outer extremities of the inside of the evacuated tube, away from the tremendous heat.

This condition, presents very little opposition, for the vaporizing Aluminum which is to be deposited, in the center of the bulb. It also presents more opposition, to the vaporizing aluminum particles, which were supposed to be deposited, in the extremities. Therefore, there is a greater amount of aluminum vaporized/positioned, in the center area, than that, of the extremities.

The REASON for the **BULLS-EYE!** The quest for **BLANK-OFF!** See **BLANK-OFF** below. The **Electron Stream**, needs the power of at least **5,000-10,000** Volts [dependent on tube size], placed on the Anode, for the **Electron/Ion** stream, to be able to penetrate, {and illuminate), the Phosphor, residing in front of the deposited, solidified aluminum.

While the **Electron Stream** has the speed/power, to penetrate the thinner portions of the aluminum deposition, it is **LESS able** to penetrate the thicker, center-parts of the aluminum, presenting a Black (because some of the accelerated **electrons**), do **NOT have enough** energy to penetrate the thicker aluminum), thereby presenting a **BULLS-EYE**, image).

If you continue to reduce the high voltage, the **BULLS-EYE** attains an ever-widening diameter evident on the lighted screen. Lowering the high voltage towards **5,000** Volts, would reveal the **BULLS-EYE DARK AREA**, growing such, that it now occupies more area, than the lighted portion, (outer edges), of the CRT.

**BLANK-OFF** occurs, when the High Voltage is continually reduced, (down to approximately **5,000** Volts), with **NO** appearance of the dark **BULLS-EYE**, and the screen goes to black. You will find that, that brightness of the **RASTER**, [a fully-illuminated **WHITE** screen, displayed with **NO** video information], is excellent.

This **BLANK-OFF** of the raster, while never approaching actual outside use, is important, because it indicates that the aluminum was deposited, in an excellent, low-gas environment. The tube is thereby well able to perfectly display, all shades of gray, black or pure white

**NOTE:** Whenever such a perfect Aluminized Tube Raster is displayed, perfect focus is easily demonstrated, by the appearance of sharp, horizontal scan lines, going into, or out of focus, as the focus voltage is increased/decreased.

### **WHY DOES THE BULLS-EYE OCCUR IN THE PERSON'S HOME, BUT NOT IN THE COMMON TESTING PROCEDURE(s)?**

The **ANSWER** to that question is: many different voltages, are generated from **STEP-UP/STEP DOWN TRANSFORMERS**, inherent in the T.V. Chassis's. The High Voltage circuit, (**FLY-BACK TRANSFORMER**), chiefly responsible for accelerating the Electron Stream, is extremely sensitive, to the varying voltage inputs from the local Power Company(ies).

Generally, the Power Company(s), will deliver **NO lower** than **108** Volts A.C., but **NO higher** than **125** volts. Prolonged exposure to either extremity will cause problems, in different chassis voltages, but especially in the High-Voltage generation. Further, many times, as the set ages, voltages become critical. In those days, the voltages were controlled by small tubes, (unlike solid-state), in associated circuits. These tubes, **ALSO**, started losing power with age.

#### **In the final analysis, the BULLS-EYE problem occurs:**

- 1) When the CRT has been sputtered in a low or gaseous vacuum,
- 2) Coupled with lower minimum A.C. Voltage, in the T V set, and
- 3) at certain critical light/dark scenes being received/portrayed by the video information sent to it. This may be a fleeting, temporary occurrence, or a lengthy, [of several minute duration], event. See **EXAMPLE** next.

**EXAMPLE A 16"/17"** Television set, will have a requirement for an Anode Voltage of some **14,000** Volts. At that voltage, the **BULLSEYE** will **NEVER appear**. But, when the Input A.C. voltage approaches (**108**) Volts, and the video does **NOT** require certain lightening/darkening of the picture, it may be of such minimum duration, that the persistence of the phosphor, negates that problem. But, when there is prolonged minimal input-voltage, (**108** Volts), vs (**112**) Volts, the **Bull's-eye** would appear more frequently, than **NOT**.

In practice, when this would happen, and if under Warranty, the consumer would demand and receive, a **FREE** replacement CRT. Later on [years], as the T.V. set ages, there will be a normal degradation of voltage(s), from the chassis tube suppliers, and be of such infrequent notice, that the consumer will opt, [because of monetary consideration], to ignore same.

**GET RID OF ALL TRACES OF LACQUER IN THE TUBE INCLUDING THAT DEPOSITED ON SCREEN:  
BAKING THE BULB AT HIGH TEMPERATURE**

1. 9 Place the Aluminized tube in an high temperature heating Oven and bake at **410** Degrees C , {slightly higher that of the regular processing Temperature (**400 C**)}, which will be done later. Essentially, this baking cycle, will thoroughly dry all material, put into the bulb, for processing, and to initialize de-gasification. Most importantly, the high temperature will vaporize, to the atmosphere, ALL Lacquer put in, (including that, which also covered the Phosphor Screen), via the previous operation.

When the high-temperature baking process 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, assisted by the solidified aluminum shield, (however thin), coating. Elapsed time about (**45**) minutes.

**VISUAL INSPECTION OF ELECTRON GUN, BEFORE SEALING INTO THE TUBE NECK:**

First, prepare a tray (**5 X 12** ), of “**DRESSED**” guns, to be sealed into the neck of the Bulb, so that 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 them in gently, to the desired (**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 cathode coating oxides into carbonates, from which the supply of **electrons** is generated!.

If the conversion process is **not completed**, when under vacuum, then when the tube is sealed off from the vacuum system, it will release additional gas, which will shorten the life of the Cathode/Tube. When, the filament is located further away from the Cathode, such will impede the conversion process, in fact have the cathode retrogress , into a less electron-emitting material. It will also create a longer **WARM-UP time**, [more that (**10**) seconds], which is **not desirable**, in the operation of the TV 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 the diameter, 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.}**. It could also generate, visually and acoustically, a **(60) Cycle hum**. Eventually, it would cause a **“Short Circuit”** and burn out the Filament.

Next inspect the grid connections and the Cathode connections. Make sure they are **NOT touching** other elements, or even, **NOT connected**, [broken or failed weld]. Adjust **(DRESS)** all wires to stay close to the tubulation of the gun, so that they may easily fit into the pin of the un-movable portion of the individual revolving heads, of the sealing machine. When visually inspected **O.K.**, fit the glass tubulation(s) into the glass tubulation-diameter holes, in a **(5) by (12)**- holed tray], **(60 Guns)** for use, as needed, in the Sealing Operation.

### **PREPARING FOR THE ACTUAL SEALING OPERATION**

1 10 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**. **NOTE:** 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, which is placed near the sealing machine and placed, **NECK ONLY**, in that preheated, **250 Degrees F** oven. This small oven contains temperature-controlled, Gas-air fired, burners. This preheats the neck only, where work will be done.

The sealing machine joins the glass, **WAFER-LIKE** Glass-part, of the Electron gun, (which contains already encapsulated, sealed wires), to the glass neck of the Tube. It does this by melting a part of the glass neck, (at a pre determined distance from where the neck joins the bulb proper), **merging/joining** the bulb neck and the gun, into **(1)** piece.

The Electron Gun Elements/Structure, is also attached to these wires, as well as providing support for the entire gun structure.. The wires will provide electrical connections to those elements, (which will be under vacuum), to the voltage-providing circuits of the **CHASSIS**, which emanate from, and are located **OUTSIDE** of the vacuum. Time elapsed in oven pre-heat, approximately **(5) Minutes**.

### **SEALING-MACHINE DESCRIPTION AND PROCESS**

1 11 A large Plate, **(3 to 5 feet in diameter)**, on the **SEALING MACHINE**, revolves at **(1) complete revolution every (6) minutes**. The Plate is programmed, to go to **(8) fixed positions**, per every **45 seconds**. Of the **8 positions**,

**1st**, is for loading the Tube, **(NOT in a fire-zone)**;

**2nd & 3rd** positions are in pre-heat Fire-Zones, **(Gas/air)**;

**4th & 5th** positions are in the WORKING-fires, zones, **(Gas/Oxygen)**; again,

**6th & 7th positions** , (Gas/Air), of annealing fires;  
**8th**, another fire-free zone, for unloading the sealed-gun tube.

On this large diameter revolving plate, there are a number of revolving “HEADS”, (from **Two to 4 Heads**, (dependent on the size of the machine), located on the outer side of the circumference of the main plate. These revolving, (**15 RPM**) ”heads”, are constructed such as, to hold the Tube, in an upright position, (neck down). Located in the center of each, is a fixed-height, hollow **STANDPIPE**.

This standpipe arrangement, always remains fixed, at the same height, (for ALL heads), at all times, while the head may be moved up or down. At the very top of the **Standpipe** arrangement, there are removable parts called “PINS”. These pins, (about **1 1/4 inches** in height), may be extracted and other types put in its place. (I do **NOT know** why they call them **PINS**, because they sure do **NOT** look like a **PIN**).

These **Pins** may be exchanged, when they wear out, because the tops of them are exposed to **GAS/OXYGEN** fires, in the normal operation of the **SEALING MACHINE**, which eventually burns away the top of the pin. This is **NOT desirable**, because the glass-working fires are positioned relative to the height of the pin. When the pin is lowered, (because of degradation), the working fires, (**Gas/Oxygen**), are **NOT** then in the proper place.

The cut-off positioning would then be **ABOVE** the glass wafer of the gun, **NOT below**, where it belongs. Otherwise, the principal reason for exchange is to accommodate different glass diameters of the tubulations, [from Twenty Millimeters (**20 MM**), to **3/4“ I. D.**, which of course also has varying wafer sizes], for the multiplicity of different tube types/sizes.

While the heads, holding the gunned tubes may rotate about **15 times** a minute, the main plate, is timed to rotate at only (**1**) fixed POSITION per **45 seconds**, {of Eight (**8**) positions}, or (**6**) minutes, to make (**1**) complete revolution). As previously disclosed, (**1**) position is to load the tube on the Head, while another position is used to unload the sealed-in **Electron gun**.

Because of the many differences in tube shapes/types, (Round, rectangular), and varying deflection Angles, the tube neck-Lengths vary in length, (anywhere between (**3**) to (**7**) inches). Measurements, at the time of sealing, are accomplished by a cardboard, (corrugated), ruler, marked-off for various neck lengths. Any metal ruler 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, remnant, bottom part of the neck to be able to drop after sealing,[assisting the gravity drop], (of at least (**1**) inch, but not more the (**2**) inches). This dropping action, both thins the glass at the appropriate point, but also assists the molten Glass of the neck, to be forced into (by the thrust of the **GAS/Oxygen** fires), the neck.

Thus it seals, AND severs the molten glass, from the CRT and the piece to be discarded. That is a reminder, that **Pin** height is very important. Severing, is then

started/assisted , by using a tweezers (about (4) to (5) inches in length). When used in conjunction with air pumped into that area, plucks the glass away. The cutting/melting of the molten glass freeing the wafer from each other, completes the **Electron Gun** sealing-in process.

At that point, air is introduced into the tube itself, through the tubulation, as to counter-act the force/pressure of the Gas/Oxygen Jets and to ROUND out the area which was molten, as it is now starting to cool and harden (set up). Glass, does **NOT like/want**, sharp edges, **heavy corners nor thick-and-thin**, adjacent areas.

(Annealing/cooling periods for each are so different, that they set up a strain in the glass at that point. Glass is always much stronger, when it is rounded out. IF it must be thick for any reason, then considerable time and care should be allocated to SLOWLY cool/(anneal) it, or it will surely crack at a later date.

### **SEALING-MACHINE PARTS:**

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 wires for future connections), AND the tubulation, (straw-shaped, with a 3/8" inner diameter).

The tubulation will be used for attachment to the Vacuum Pumps, {the next step, when annealing is completed}. Then, there are **Two** 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".

### **ANNEALING PROCESS AFTER SEALING:**

The tube is then placed in a "cooling"-oven (neck and gun only), which is set at approximately 150 Degrees 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 (14) minutes. **NOTE:** If a (2) headed machine is used, then that time may be reduced to (7) Minutes. A **4--Headed** machine may reduce the time to (3) minutes. High-production machines usually have the ability, and the necessary resources, to seal **One** Tube, per Minute.

### **"PUMPING": PUTTING THE TUBE UNDER HIGH VACUUM**

1 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. This tubulation is used to attach the Tube to the **VACUUM-PRODUCING PUMPS**. This is accomplished either of (2) ways:

#1. When using Glass-Oil Diffusion Pumps, (see description of GLASS and/or METAL **DIFFUSION PUMPS**), a Glass-to-Glass joining of the CRT, called **SPLICING**, [VIA THE TUBULATION], and the Vacuum system, is made with a **gas/air** torch. In the following

manner, cut the glass "RISER," [tubulation], protruding **UP** from the Glass manifold, (by scoring it with a knife file), and snap it off with your fingers.

1. Then measure the glass tubulation, emanating from the Glass wafer of the **Electron Gun**, (by eye, coupled with experience). Match it up with the Diffusion-pump riser, just prepared/cut, and score IT with the knife-file. Then snap that off also. Then, using a hand-held, **2**-headed gas/air torch, (held together by a U-shaped torch, with jets facing each other), pre-heat the glass [both ends], gradually increasing the heat, until both ends are molten.

Then place one end on top of the other, until melted together. To assist in the splicing maneuver, access to the inside of the **Diffusion pump** manifold/system, (including the Tube being sealed in), is provided by a small tubulation, (see next PP), thru which the operator may blow into the area which is being worked on. This is also part of the glass-manifold, as well as a part of the **Diffusion-Pump** system).

This is so that you may counter the force exerted, {while joining the 2 pieces of glass}, from the Gas/air flame (Torch) . A rubber-tubing when affixed to the small tubulation, is used by the Sealer, in the following manner: One end is attached to that manifold tubulation, while the other end of the rubber tubing, is fitted with a hand-made glass mouthpiece.

This allows the operator, to blow air (from his mouth), at the appropriate time, in the splicing operation. When the splicing is completed, **AND** annealed, then the Gas-air torch, is used to close off that small tubulation also, so the whole system is Vacuum-tight/ready.

A small CRT manufacturer, might use **(2)** STATIONARY OVENS, each capable of containing **(2)** movable units, (on rails), with each unit containing **(6)** Picture tubes, which were sealed in (as just discussed). The glass manifold connected **(2)** tubes, (on opposite sides of each other), on every movable unit. There were **(4)** movable units, (each unit, comprised of **3** pairs, for a total of **(6)** Tubes.

Each **2**-tube combination, joined by a Glass manifold, was attached to, and an integral part of the system, which was powered by **(1)** Mechanical Vacuum Pump and **(1)**, **3**-stage Diffusion pump. There were **(2)** operators, to treat these **(4)** units. The ovens, could each hold **(2)** movable units, at the same time. Each operator would work on **(1)** Unit at a time, in the following manner:

Assume the Ovens were situated in an **East/West** alignment. **(1)** unit, situated on the **South** side, is pulled out of the Oven, by **East Operator #1**, (each leaving a unit still in their respective, **[East/West]**, side(s) of the Oven.) **West Operator #2** pulls a unit out of the Oven on the **North** side. Each operator works concurrently, but independently, of the other.

When each Operator is finished, (tipped off), his unit, of **(6)** Tubes, he then seals in another **(6)** tubes , to be processed, and shoves it back into the Oven, (where only **(1)** Unit

remains). In the meantime the other operator does the same on his side of the oven. Then **East Operator #1**, pulls a unit from the **North** side of the oven, while **West Operator #2**, pulls a unit out of the **South** side of the oven.

Each complete cycle (as hereinbefore explained), takes **2 Hours**. Since this "**PUMPING**" operation, continues around-the-clock, on a **6-day** basis, the maximum amount of tubes, expected to be pumped, (manufactured), at this plant, is **(864)** tubes per week. Any tubes lost in the process will be deducted from the total.

**NOTE:** Having **(2)** tubes on a manifold is less costly for initial start up and even for maintenance requirements, the weak point is, that when you lose **(1)** Tube, you also lose the other, because they are both attached to the same exhaust system.

As this small manufacturer grew, he generally opted for a continuous **in-line tube-exhaust system**, using Metal Diffusion Pumps. This system, consists of a large number of Dollies, traveling through a long structure, **75 to 100** feet long, (depending on production requirements). The structure is compartmented off, with the Dollies shielded from each other, (as protection from implosions from preceding/following units), so that the tube(s) going through the length of it are:

1. **Preheated;**
2. **Incrementally brought up to temperature (in 3 or more Zones);**
3. **Kept at 400 Degrees C., 732 Degrees F., for 1/2 hour;**
4. **Cooled/annealed, (in (3) or more descending-heat-supplied Zones); and (2) or (3) no-heat-supplied Zones.**

Each unit, [Dolly's], are attached like train cars, and contain a Mechanical Pump, (main vacuum-producing pump), **AND** a Metal Diffusion Pump, (gas-removal), pump. Each tube is mounted, [neck-end through], an **R.F-producing coil**, when the **R.F.** generator calls upon it, so that the **Electron Gun** may be heated, for de-gasification. Wires emanating from the **Electron-Gun** are then attached to a power-supply, by spring loaded copper fingers, emanating from each dolly, connected by copper strips to the structure proper!.

Each Dolly also has means to access the **R.F.** (automatically). The filament voltages, are fed, (incrementally), up, to a "**hot-shot,**" and down again. Each Dolly has a large piece of metal, that acts like a shield, (for protection from **IMPLOSIONS** from other Tubes, in the assembly-line dollies).

The metal diffusion pump receives the tubulation of the Glass wafer of the Electron gun, which is fitted into a "**compression port**", (which is part of the Vacuum arrangement). That compression Port, is part of the **3-stage** oil-diffusion pump, (sometimes referred to as a (Fractionating Pump). It is constantly water-cooled, as the compression structure, (**NOT** the whole pump), **IS** in the heated oven. The primary, high-speed Mechanical Vacuum Pump, for both the Glass or Metal diffusion pumps, is the same, in both cases, but **NEVER** in the heated part of the oven!

## **TYPES, COMPOSITION, LOCATION and FUNCTION OF VACUUM PUMPS**

The Glass **3-stage Diffusion Pump**, is a **3 1/2"** diameter Glass manifold, (Main body), which has **(3)** round glass Pots, [(**2**) of which have **(2")** diameter and one, at the end, of **(1)"** Diameter, [called a "**condensing pot**"]. The Pots are arranged below, and connected to, the Main body, and also inter-connected to each other. One part of the Glass pump is connected to the Glass manifold, through a Glass trap, (much like the one under your sink). That connection is made with a high temperature sealing wax, coating the "**GROUND-Glass**", male end, of the manifold, to the Ground-glass female part of the Glass Trap.

### **BACK TO THE POTS:**

Each of these Pots, contain a heating element, {which looks like a thick element in a light bulb}. When the Vacuum system is in operation, the **(3)** stages, each individually vaporize the oil in them. As the Oil-vapor rises, it goes through the main body of the Glass-pump, until they each enter their own section of water-jacketed parts of the Main body.

Then, the vapor, mixed with the molecules of gas being generated from the Tube, condense and fall back toward the original source ... the Pots. This is basically, a re-circulation of the oil. It does have the effect that, it compresses the gas molecules, and passes them over to the Mechanical Pump, where the gasses are then transferred to the atmosphere.

There were several types of oil used, in both Glass and Metal Diffusion pumps. **(2)** of the most Common were "**OCTOIL S**" AND "**SILICONE**" OIL. In the **1950's**, the **Octoil S**, was priced at **\$10.00** Dollars a gallon, while the Silicone Oil, was priced at **\$125.00** a Gallon. Octoil S had to be replaced, every time the system was reduced to air, while the oil was at operating temperature.

This was because **Octoil S** oxidized and was **NO longer efficient**, at de-gassing the system, whereas **Silicone oil** was, "**stable to air at operating temperatures**". This saved many hours of "**down-time**" (ovens **NOT producing**, loss of production, because of work to be done, as follows:

1. The Glass Manifold above the trap, was first removed;
2. the connection to the Mechanical pump was dis-connected;
3. then the pump was loosened from the supports underneath the Oven, and removed.
4. The Diffusion pump was then emptied, cleaned out, dried, and new OIL, [**Oct-Oil S**,] introduced. This happened every time, there was an implosion, and/or, for whatever reason, the Vacuum system was exposed to air, while the oil was hot.

**NOTE: Silicone Oil**, expensive as it was, (**100 \$** per Gallon), had several distinct advantages over the **Octoil S**. Besides being stable to air, at operating temperatures", importantly, gas remaining in the system was much less [predicting a longer life for the tube(s)] An "**Ionization**" gauge was part-of/attached to the manifold/tube also.

When gas pressures reached the (5) times (10) to the Minus (5) range, or better [lower,] after processing, [immediately before "TIPPING-off,] the CRT's would be removed (tipped-off). It was **not unusual** to find most tubes in the Minus (7) range.

When working with small tubes, such as the 5", 7", 10", 12," 13", or 14' rectangular, pressures in the (1) times (10), to the minus (8) range, could be achieved. **EXPLANATION:** The speed of the pumps was the same, but smaller tubes, had less volume to be evacuated. Of course then, there was less material contained therein, to generate additional gasses. Hence **better/lower**, Vacuum pressure(s), could/**WOULD BE ACHIEVED**.

### **METAL DIFFUSION PUMPS**

Basically, the Metal Pumps, were composed of an upright (3") diameter piping, (metal sleeve), about 14 inches in height. To heat the oil, [which effected the gas-removing aspects of the pump], it contained, an Insulated Metal Coil, [so it wouldn't short out], because everything was made out of metal. This coil was located in the pot, [at the bottom of the cylinder].

The top of the pump, had a compression arrangement, which received the tubulation of the CRT. A copper 1/4" tubing, was wound around the entire body of the pump. This copper tubing, was sealed **100%** to the pump, so that it came with, and was part of the pump. This was connected, on installation in the oven, to a water line. If **NO water**, is used, then the pump will **NOT work**. Worse yet, if **NO water** is used, then the oil vapors, rise into the Tube itself, and poison the Screen AND the Cathode coating.

At that point, all materials **AND** work are lost, and the tube(s) must be re-built. Inside the metal pump, is an insert composed of a metal cylinder, shaped **not** unlike a Christmas tree, the bottom of which resides in the pool of Oil. When the oil is heated, there are (3) separate exits in the Insert, (in effect a 3-stage pump], for the Oil vapor to rise, mix with gas generated, condense and transfer the compacted gas molecules, to the mechanical pump, for evacuation from the system.

All pumps, are always located, **BELOW** the Glass manifold/compression port, (**NOT** in the gas-heated portion of the oven), BUT ARE part of the Vacuum System, which IS, in the **400 Degree C** , (**752 Degrees F** ), High-Temperature Oven. There are (2) Vacuum Pumps, for each tube to be processed, at the same time, as they are being baked.

The reason for (2) Pumps is, because there is no single pump which may pull the high vacuum, necessary, for proper-functioning and long life, of the Tube, at an extremely high speed, as economics demand.

The Mechanical pump is required, to pump out rapidly, the tremendous amounts of gasses involved in manufacture. These gasses are both inherent in all materials used for its construction, as well gasses being generated by the great amount of heat by the high temperatures used in processing. At the same time, they are required to produce an extremely low gas-containing condition.

**NOTE:** Since water,(which is composed of Oxygen and Hydrogen), was used in copious amounts, it was found that to complete dis-association,

(separating Oxygen from Hydrogen), in water, temperatures under vacuum conditions, would require at least **385** Degrees C, (**725** Degrees F), to so do.

### **TYPES OF VACUUM SYSTEMS (PUMPS)**

1. The High-Speed mechanical vacuum pump, very rapidly, [(**4**) to (**6**) minutes, depending on the tube size], evacuates the system, {which also contains a secondary pump, called a (**3**) stage “**Oil Diffusion Pump**”. That **Diffusion Pump** is responsible for achieving very low gas conditions, while the Tube is being baked. Additionally, it is removing the **Gas** which is also being **generated/liberated**, by the **400** Degrees C., (**752** F), heat of the oven. It will continue to remove gas, generated from processing, (to come), of the Cathode Coating(s), **AND** the **Electron Gun**.

In the past, **Mercury-Diffusion Pumps** were also used, but have long been discontinued due to **Mercury’s** extremely toxic nature. The fact that **Liquid Nitrogen** was necessary/**HAD** to be used, for them to function properly, was dangerous to use, hard to store, [because it had to be kept cool], and costly, caused their abandonment.

**Liquid Nitrogen’s** normal temperature is about **250** Degrees **BELOW ZERO**. Even when you were **NOT using** it, the supply was always being diminished, because of it's extreme temperature difference, with the ambient room temperature. Despite the fact that it was stored in a large vacuum type container, (**NOT unlike** a **THERMOS BOTTLE**), it continually was evaporating, during Holidays, weekends, etc., whenever the Tube plant was **NOT!**

2. The **Diffusion Pumps**, are very effective for pulling gas molecules out of the system, (regardless whether the Gasses are Oxygen, Hydrogen), or of any other type. There are many Gasses, whether residual, or, which are constantly being generated at the time of processing, which must be removed from the system.

Myriads of **OTHER** gasses, which might have been **ADSORBED**, (attached to the outside of the parts, materials, used in processing, construction), **OR** during the Electron Gun’s Electrodes (parts), also had to be removed. The Gasses are continually, efficiently, gathered together and expelled to the atmosphere. Gas causes problems, aptly demonstrated, in use, by “**Fuzzy**” pictures.

You just can **NOT get a clean, clear picture**, with a high gaseous internal-tube condition. In high Gaseous conditions, it always looks like the picture is out of focus. **EXPLANATION** to follow:

**EXPLANATION:** As the **Electron Beam** tries to go to its assigned position(s), it encounters molecules of gas and collides with them, which causes the **Electron Stream** to be deflected (nudged), left or right, or up, or down, and/or, even in a combination of **ALL** directions.

Therefore, the **Beam** impacts **different portions** of the Phosphor Screen. It does this, so many times, each second, so that an **AVERAGE**, (sum of all the different **ELECTRON-BEAM** landings), video-picture, is actually displayed. This is also aided, exacerbated, by the

DECAY-time factor, hence a “blurry” picture, (even though the **Electron Stream** is 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 deposited, non **electron-releasing**, coating.

Worse yet, it reverses, has a dampening effect/ability, for **Electron-generation**, in the good, Cathode coating. This smothering effect, encourages an ever-slowng, Electron-generation ability, which eventually leads to the purported death of the Cathode/Tube. (IF YOU DON'T USE IT... YOU LOSE IT)! SEE N

**NOTE.** It was found, that even though it appeared that a CRT was “dead”, an apparatus, operated by a Technician, could apply about a **1,000** volt (RE-ACTIVIZATION), momentary spike, between the Cathode and G 1, the coating could be disintegrated, and the Cathode Coating would again be able to function properly, for many, many, more years.

### **HEAT TREATMENT(S) OF BULB AND ELECTRON GUN**

1 13 The oven is then heated to **400** Degrees C, (**752** Degrees F.), in stages of incrementally-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 **425** Degrees C, some thin glass tubes, will start to go soft/ plastic, (especially tubes such as DUMONT round **12"**), and start to deform. 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 (**16**) pounds +, per square inch, exacerbated by the extremely high temperature, to start to soften the Glass Bulb **AND** actually begin to cave in.

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**, in a **longer time**, (**ANNEALED**), than that which would be natural, 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 because the pieces rush to, and, **THROUGH** each other (much like the “**crossing point**” phenomena, but with dangerous effects. Time in baking procedure, about (**1**) hour.

### **PROCESSING THE TUBE (CRT) AND THE CATHODE COATING**

1 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 raised, incrementally, to a (**30**) second

**“HOT-SHOT” (12 V to 13 Volts), and then incrementally back down again, but never less than (6) Volts.**

Simultaneously, [from time to time], the door(s), to the oven, are opened more and more, while the Voltages are being applied. Total cool-down time, and voltage application cycle, approximately **(30) minutes.**

Alongwith the voltage application and the cooling of the oven, another very important part of manufacture is also taking place, namely: Supplying an additional source of heat, to the **Electron Gun** itself. It is accomplished by application of an **R. F.** source via a **BOMBARDER, (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)**

First, the **BOMBARDER** heats the G 1, [along with the Cathode Cylinder], and G 2, to a bright-red degree, for **(1) minute.** Then separately, the Electron Gun Anode structure, is also heated at that Red Brightness, for **(1) Minute.** This is done for **(2) reasons:**

1 of 2 To expel any gasses which were used in the manufacture of the Electron Gun, and/or to force any and all gasses, adsorbed/absorbed in **ALL** of the parts enclosed with/within, the G 1 structure, as well as the Anode itself. **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. See next **(2) Paragraphs.**

When the tube is finished and put into operation, at first, the Tube will function normally. Later, as early as several weeks, because of heat generated in the normal operation of the T.V. set, the **Spiders** will start to vibrate, **“SING”**, making a high-pitched ringing sound. The video (PICTURE), WILL SHOW BLACK HORIZONTAL BARS ACROSS THE SCREEN and immediately be **NOT viewable.** Of course, 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 is still 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.

### **CONVERSION AND ACTIVATION OF THE CATHODE-COATING:**

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, (encased within G 1). R. F., [low-range Radio Frequencies], (as earlier herein discussed), is applied. This**

helps to start uniform **conversion/activation** of that Cathode 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**, a mix of **(3)** Cathode coatings, (in liquid-powdery form), are sprayed on by a Paint-sprayer device. Then the deposited coating dries, and is shaped to an **EVEN-surface**, with few, if any irregular (high spots).

Then the series of electric voltages applied, rising up, in increments, from **6.3** Volts to a **(1)** minute **“Hot Shot,”** (**12 ½** to **13** Volts), and then incrementally being decreased back to the original **6.3** Volts, completes the conversion and activation of the Coatings.

15 Now that, the conversion/conditioning, of the CRT (Cathode Coating), is completed, the wires attached to the filament are disconnected and the CRT is separated from the Exhaust System. Care should be taken NOT to allow air to be introduced into the CRT). The separation procedure, may be effected, in any of the following manner(s).

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

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 and the Cathode-Coating is destroyed). As the glass becomes soft and pliable, the process called (**“TIPPING OFF”** ), commences.

Atmospheric- pressure, coupled with the force of the Gas-Air Torch, causes the Tubulation to start to collapse. As the Tubulation starts to lose diameter and the Glass becomes even softer, the CRT is slowly raised to making the diameter even smaller/less. Continuing the **heating/lifting** the CRT, until it comes to a thin thread of string, and ultimately, the flame actually severs the CRT glass, 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, basically, because when going from **THICK** to **THIN**, each should each have their own annealing minimums, and they are too dis-similar. This separating operation, requires some strength and certainly skill, in maneuvering the torch **AND** the lifting procedure, being **done simultaneously**.

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 took **(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 had the effect of retaining the enclosed heat, hence (ANNEALING) the **BLOB**.

This cooling period took 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. A metal file, (shaped like a knife), made a FIRM, QUICK scratch, "SCORE MARK" to the middle of the Blob. Then making a quick blow to the blob, causes the glass to be separated, at the Score- mark.

The "GETTERS", are then activated by the hand-held R.F. coils, by the operator, (as previously discussed). This absorbs any additional gasses, which might have been generated, by the heating/melting of the glass, in the separation/processing, [tipping-off], of the CRT.

The Tube could then be removed for the next step. The Oil-diffusion pump is 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].

The Oil degraded very rapidly, to the point, that the Diffusion Pump worked less and less efficiently. Then the Mechanical Pump was also turned off. Then air was introduced into the system, (the Vacuum system was broken). The remaining piece of tubulation, was then withdrawn from the system and discarded, (preparatory for the next pumping operation). Total elapsed time, in the oven, {turn-around time, (2) hours}.

### ATTACHING THE BASE TO THE CRT

16. Removing the CRT from the oven, it is put (face-down) on a soft surface, so as NOT to scratch the face. A Bakelite cement, composed of a special powder, mixed with de-natured Alcohol, which attains the constituency, {and looks like}, peanut-butter is applied inside a Bakelite base. This base, in turn has several functions. The (1st) is, that it protects the Glass tip from accidental breakage, in normal handling. Next, it contains a ring of hollow metal tubings, through which wires will feed though from the evacuated tube.

This provides electrical access to the Elements of the Electron gun and chassis-supplied voltages (instructions). Again, the filament wires are connected to a Power Supply and a series of electric voltages are applied. The Voltages range from 6.3 Volts to a Hot Shot of 13 Volts for (1) minute and then back down, incrementally, and finally to 6.3 Volts.

This completes the activation of the Cathode Coating and "AGES" it. That is to assure, it may produce enough Electrons in (10) seconds, in the T.V. set, such as to provide a complete viewable picture, for many years. See "Aging" of Cathode Life-cycle below.

The solidifying process, (evaporating of the de-natured alcohol), concurrent with the AGING process, normally takes about (30) minutes.

NOTE: "AGING" THE CATHODE is necessary, so that a CRT may last many years. It should NOT be allowed to fail, at least for the first (18) months. Generally, there was a One-year guarantee given. If the CRT was returned "under warranty", then, a new one has to be sent at NO CHARGE, (but at considerable cost to everyone, manufacturer, distributor and serviceman!).

## LIFE-CYCLE OF THE CATHODE COATING/CRT

A. Initially the coating is in a non-active state and will NOT readily release Electrons/Ions.

B. As the Coating is heated, (in a Vacuum condition), it completes a chemical re-action, (conversion of Oxides to Carbonates, which makes it start to become, increasingly active .

C. The reason for the increasing activity, is that the coating, (under a microscope), reveals many **high-spots**, mixed in with many low spots. The **low spots**, (thinner layer of coating), react quicker. Therefore, some areas will **converted**/be **activated**, sooner than others, (the thicker parts).

D. Life-cycle explanation: When the Cathode Coating is properly converted and easily producing **electrons**, it starts out, (on a 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 curve, the Coating will **NOT** continue to **improve**, but in fact recede, to less favorable electron-generating conditions.

At that point the tube might be sent back to the production line for additional **“Aging”**. If again, it displays **“unsatisfactory”** readings, (on the Test Set), 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, {with the new Cathode Assembly also}. This was done at **1/2** the cost of a new gun, but was actually indistinguishable from a new gun.

**NOTE** Failures in the manufacturing are known as **“SHRINKAGE”**. 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/highest level of activation).

E. When it is producing the maximum amount of **electrons**, it will stay on a **plateau** producing plentiful Electrons, for from, **(5)** years, to **15** years, or more. **NOTE:** Many tubes were found to still be producing a decent picture, **50** years later!

F. It will then start on the down-slope of the curve, which should be another **(20)** months or so. **NOTE:** When the Cathode Coating is **OVER-PROCESSED**, you may be well across the plateau or even on the down-slope, even **BEFORE**, the CRT is installed in a consumer's T.V. It might then fail, in less than the guaranteed minimum. This failed CRT, entitles the consumer, to a free replacement under Warranty.

G. Ultimately, back to a state where sufficient electrons may **NOT be generated**, (coating expended), Life-cycle ended! **NOTE:** By that time, consumers will have purchased newer T.V. sets.

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

The Bakelite cement originally comes as a powder. When mixed with pure, [de-natured] alcohol, which is an (easy, non-contaminating, evaporation material), it is worked to the consistency of “Peanut Butter”. A 3/8 " 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 through those metal pins and pulled tight to mount and fix the Bakelite Base and cement, to the glass of the CRT neck. [That is where the Glass-like Wafer of the Electron gun was melted into the neck of the Tube]. That also protects the **Glass tip**, from being broken, with the resultant loss of Vacuum.

Those wires also held 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 from the Vacuum PUMPS, in the **Blob**-configuration, that a very high, un-acceptable amount, suffered leaks.

Then new tubes had to be supplied. . REASON FOR FAILURE: It was proven later, that the INSIDE of the tubulation was **NOT as clean** as it should have been, and therefore, an extremely fine line left in the center of the **blob**, was actually leaking air, into the finished tube.

The **leak** was so **minute**, that it took several months of rising gas content, eventually air, to be discovered. But, it was able to be effectively closed off, with a High Vacuum, Red-Paint sealant, [was specifically formulated for just such a purpose(s)].

This Sealant was applied to the Blob-end of the CRT, at the beginning of the base-attachment process. The sealant was NOT needed, for hand-tipped tubulations. It also had electricity-insulating characteristics. To provide the necessary heat, for the Bakelite Cement-hardening process, the Filament wires are again connected to an A C supply, to further age the cathode, (with the obligatory “Hot Shot” {12 1/2 V to. 13 1/2 V for (30) seconds}).

Depending on the ambient room temperature, sometimes “spot lights,” shining on the base, might be necessary, to complete the evaporation of the alcohol and the hardening process, of the Bakelite cement.

At 6.3 Volts A C, the filament generated approximately 800 Degrees Centigrade of heat, or about 1472 Degrees Fahrenheit,(and higher, as voltages were incrementally advanced), so that the Glass in the base area, gets hot to the touch and thereby hardens the Bakelite Cement.

When the Bakelite cement is hardened and the socket called the BASE, containing the wires are firmly affixed to the end of the CRT neck. Next, the wires are snipped off at the top of the pins 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 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 pins 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 button of the CRT.

The Anode is fed from a device, whose sole purpose is provide the High Voltage necessary, to clean unknown/unwanted particles, by using (25) to (35) Thousand Volts. When turned on, the H.V. disintegrates any material still present on the Electron Gun, with the (CRACKLE) sound, made by electricity. Larger tubes get 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.

If not done properly, the Electron Gun will start to snap, crackle and pop, in the customers home, which makes the customer apprehensive, (even though it will NOT do any damage). However, if the Tube develops air in it, in the T.V. Tube consumer's home, THAT, could do serious damage. That device, which was used to clean up the electrodes, was commonly called, a "SPARK-KNOCKER".

## **TESTING THE FINISHED PROCESS**

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), were available (inherent), and dial-monitored by controllable sources, (some automatic, with others on command of the Test-set operator.

For example:

High Voltage was supplied from Zero ("0") volts, all the way up to (35) Thousand volts. (NO T.V. set, under law, operated at more than 30 Thousand Volts).

### **Other variable voltages available in the TEST-SET are:**

Filament voltage from (0 V) to (15 V), w/ automatic current drain in Milliamps. (most CRT's operates at 6.3 volts).

G 1 ("0") V to 40 V

Cathode (-10 V) to ("0") V + current drain (called "EMISSION," the aggregate of electrons passing from the Cathode though the aperture of G 1), in MICROAMPS.

**NOTE:** There is a relationship to the amount of **Electrons** emanating from the Cathode, through G 1 and the amount of voltage necessary to completely halt that action, which allows the T.V. show, to produce the color "BLACK".

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.

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

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

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

The TEST SET has the ability to test for "LEAKAGE" between the Cathode (A.C.), & the G 1 (D. C.). Too much leakage, would introduce a **(60)** Cycle "Hum" in the Picture, (undesirable), getting progressively worse. It also guaranteed that eventually, the filament will short against the Cathode Cylinder, and burn out. (See **SEALING** the **ELECTRON GUN** hereinbefore, to **PREVENT** leakage).

### **ASSESSING THE POSSIBLE LIFE OF THE CRT**

The Test-set also had the ability to disengage the "**SWEEP**" circuits. This is a valuable tool, in assessing the effectiveness of your manufacturing process, because it enables 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 is an integral part of the G 1 assembly electrode.

To get a "view", (a **VIRTUAL** look), at the Cathode coating, do the following, (**VERY IMPORTANT**), in this order as shown:

**FIRST**, reduce the Focus Voltage down to "0" Volts;

**SECOND**, reduce the high Voltage to **5,000** Volts;

**THIRD**, dis-engage the Sweep Circuits.

These actions, have **NOW produced** the following effect:

BECAUSE, the Focus Voltage, was reduced to "0" Volts, the Electron Beam could **NOT** be brought down, to an intense, very small, sharp point; Next, BECAUSE the Anode (High) Voltage was brought down to **5,000** Volts, that eliminated any possibility of the **Electron Beam** burning the Phosphor Screen; Because, the Sweeps were dis-connected, the **Beam** could **NOT traverse, up/down** nor **left/right**, thereby presenting a stationary image.

The **IMAGE**, then cast upon the Screen, (about the size of a **Silver Dollar**), was able to be read like an M D READS AN X-RAY. To a skilled person, this **CATHODE IMAGE** ("Scan"), could present a remarkably accurate picture of the expected life of the CRT, or in the alternative, if further "**Aging**" was necessary. After re-aging, the CRT had to be tested again.

An important function, relative to the percentage of tubes requiring re-aging, was vital, (NEVER more than **10 %**, nor less than **5 %**) in determining the efficacy of the Conversion and Activation of the Cathode Coating.

**NOTE:** If you got less than **5 %**, that meant, you were **OVER-PROCESSING** the cathodes, thereby using up useful life (hours), and where, on the plateau, or down-slope of the life of the Cathode coating, you were in, for the batches of Tubes processed that day. (Plateau interpretation, discussed earlier herein, in the Aging

process).

**NOTE:** Sometimes, when attempting to test a CRT, upon trying to display/examine, the Cathode image, instead of the "dollar-size" image being displayed, a rather dim image, [smaller than a dime], was displayed. When that display was received, it indicated **(2)** things.

1). The Cathode tab, [the connection between the Glass wafer and the Cathode cylinder], was broken, and therefore the CRT could **NOT function properly**.

2). The CRT had to be cut open, a new neck had to be attached, the entire inside coating had to be washed out and the whole process had to be started out again, from the beginning. In looking for the "open Cathode," a few were because the **(2)** welds made, [to attach the tab], were **NOT done properly**. This should have been detected in the preliminary examination of the Electrodes, prior to the "sealing-in" process.

However, after intensive investigation, the author determined that the vast majority, of "open-cathodes," came about because of the following: Pre Korean War, the tab consisted of a "Nickel" composition. Since a lot of Nickel was needed for military purposes, the gun manufacturers selected a different metal to be used as a Tab. This metal, [because of the intense heat, generated in affixing it to the Cathode cylinder], became brittle, at that point of the weld.

Since the filament of the CRT generates **1,472** degrees F, when the T.V. set was turned on, the Cathode cylinder expanded. When the T.V. set was turned off, the filament cooled off, and the Cathode cylinder contracted. Sometimes, the welder was not sure that he/she made a good weld, and therefore gave it another shot. Since those double welds, presented more heat than the single weld, they sometimes broke, even while the CRT was going through the process, (Cathode conversion, "Aging," etc.)

This problem was addressed by the author, and was the subject of his first Patent, [circa **1952**]. Even though the tab material was still of inferior grade, by lengthening the tab and then looping same, it was found that the **entire loop**, absorbed the stress of the **expanding/contracting** Cathode cylinder (because of the extreme heat, [**1472** degrees F ] given off by the filament . This was instead of, only the part of the tab, where the weld was made, to the Cathode cylinder, being made to bear the brunt of the **on/off** heat generation, (from the filament). This was found to be **100 %** effective, in all later CRT's, from then on.

The finished CRT's, also are visually inspected for imperfections, which might appear in the Phosphor Coating. Each tube was tested/timed to the **(10)** Second (or better), criterion, [in which a raster must appear]. The Amount of Electrons, emanating from the Cathode, is displayed, (which shows up as Current drain, in Milliamps). It also measures the amount G1 Voltage necessary, to extinguish the **Electron Stream** from view, called **Cut-off Voltage**).

There is also a necessary ratio, between emission and **CUT-OFF**, [total extinguishing of the Electron Beam on Screen]. This is a necessary requirement, (so that black portions of any picture may be faithfully reproduced). The ability to **focus/de-focus**, the **Electron stream**, is tested. It is also tested for **"SHORTS"/"Open Circuits"**, and/or mis-alignment of the Gun Structure. Such may come about, because of a broken Glass-support rod, which holds all the Electrodes firmly in place, {"ALIGNMENT"}, or any other Electron-Gun, manufacturing defect.

After the testing is completed, it is then scrutinized for scratches on the face of the CRT. If any are found, they are removed, using grinding disks, in conjunction with "Jewelers Rouge," [see "BUFFING", scratch-removal later, herein].

### **SOMETHING TO THINK ABOUT**

Let us enlarge the conventional "Straight Gun", as indicated, and place it in Earth Orbit. No envelope is needed, as the Universe will be, the Vacuum Container:

**AVERAGE ELECTRON GUN ..... EXTRAPOLATED, LARGER AS NOTED**

**LENGTH 5 INCHES ... 42 FEET (100 TIMES LARGER), [ROUNDED UP FROM 41.66 FEET]**

**FILAMENT VOLTAGE 6.3 VOLTS ..... 18.9 VOLTS ... (3 TIMES LARGER)**

**FILAMENT CURRENT .600 MA ..... 1.8 AMPS ... (3 TIMES MORE)**

**CATHODE VOLTAGE -5 V ..... -15 VOLTS ... (3 TIMES LARGER)**

**G 1 APERTURE 0.004 INCHES ..... .012 INCHES ... (3 TIMES LARGER)**

**G 1 VOLTAGE 5 V TO 40 V ..... 15 V TO 120 VOLTS ... (3 TIMES LARGER)**

**G 2 VOLTAGE 100 V TO 450 V ..... 500 V TO 2,250 V ... (5 TIMES LARGER)**

**ANODE VOLTAGE 15,000 V TO 30,000 V. 150,000 V TO 3,000,000 V 100 TIMES . . . LARGER )**

Average **"Throw" distance**, [between the top aperture of the Gun-Cathode, to the Phosphor Screen], in a **25"** CRT, is about **2** feet. Extrapolating that **100** times yields **200** feet (to expected Focus point, [2nd **cross-over point**,]). From experience with normal CRT's, the **2ND "CROSSOVER-POINT"**, may be another **6** inches, past the outside of the Glass face. **100** times extrapolation gives another **50** feet.

Therefore the **Electron/ION Beam** may be focused on any target, (for welding, blasting, etc.), up to approximately **250** feet. An extended focus coil arrangement, placed **200** feet further out, may create a **3rd "CROSSOVER-POINT"**, AND giving that an extra **200** foot range.

**NOTE:** Since a Straight-Gun arrangement is envisioned here, the Electron Stream, will then contain all the Electrons' heavyweight, brother particles, (IONS), both Negative AND Positive.

### **"BUFFING", POLISHING THE FACE OF THE FINISHED CRT**

19 The face of the finished CRT is carefully **SCRATCH REMOVAL** scanned for scratches or other blemishes in the Viewing areas. If found, a Grinding wheel removes the deep scratches, by 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, [FEATHERED]. 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, done properly, requires patience, hard work, and a high degree of skill! The work is characterized as hard, because when you finish one tube, then you go on to the next, and the next, and the next, etc. for **8** hours.

### **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**". There were several types tried. ALL required the use of **EPOXY RESINS**. Most resins became hard as a rock. The first approach was for 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 composed), **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 **Two-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 (in the firm, binding, yet pliable state).

Yet another way, provides different types of metal banding , (including non-resin coating, Compression-BANDING. This involves putting s Metal Strap around the edges of the Tube and tension stretching it, so that it is extremely tight. There will be absolutely **NO slack NOR** space, between the Band and the CRT. 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 types of implosion protection for the CRT's, which were employed, were very effective.

## **PREPARATION FOR SHIPPING:**

21 The last step before boxing for shipping, was to have a black highly-conductive Electric coating, (AQUADAG), sprayed over the entire outer Bulb area { but **NOT within a (4)** inch circle of the Anode and at least **(5)** inches from where the neck joins the bulb proper, because that is where the Yoke will reside} This coating enables the Tube to acquire a Capacitive effect, (stores electrons to give a smoother working action, to fluctuations in voltages {usually due to external sources})

## **DISCARDING/REPLACING THE CRT**

**NOTE:** Before doing anything, to the inside of the cabinet containing the CRT, make sure that the T V set is turned off. (Most sets have an automatic dis-connect, but sometimes, they may be inoperative). When removing the CRT, from the T V Set, you must also remove the High Voltage, Anode connection RED wire, hooked into the anode button, in the side of the CRT.

Make sure, you use an insulated Screw Driver, to pry under the obligatory, round rubber insulator, surrounding the button. Every precaution has been taken, by T V Set Manufacturers, to protect the person going into the Unit, from accidentally coming into contact with the button. Do **NOT touch** the Anode Button, with bare hands. It could give you a very bad Electrical jolt. It has actually killed people, under certain circumstances.

*Before handling/removing the tube, ground the anode' to an external source of GROUND, or even the metal chassis of the TV set. Whatever you use to ground the Anode with, make sure the wire/part/tool, you are using, is INSULATED. There is usually a pretty good amount of Electrical energy left in the CRT, because of the Capacitive effect. Even disconnected from the T V Set, it can still shock you. It would (NOT ) kill you, but it could STARTLE you, so that you may drop the CRT. " **THAT ...COULD HURT YOU.***

**#22 DYING, TELEVISION TUBE MANUFACTURING INDUSTRY (circa 1980's)**  
There are only a few instances today, where Television Tube ability is left/ needed today, which are not supplanted with "Flat-Screen" Technology,(circa 2000), whether they be of the LCD' *or the Plasma type variety.*

*Even projection-type TV Sets, are being phased out, primarily, because they are too bulky. Another very important reason for their demise, is that, you still need 3 CRT's, (approx. 5" round), for EVERY 1 PROJECTION-TV SET: You need ONE ALL-RED Phosphor-screened CRT; ONE ALL BLUE, Phosphor-Screened CRT and ONE ALL GREEN Phosphor-screened CRT), [PER SET].*

## **METAL PICTURE TUBES, ALREADY LONG-DEAD INDUSTRY!**

TELEVISION set manufacturers are always concerned with "Upgrading"; "looks"; "Weight"; "Competition"; "Costs"; and last, but not least, "PROFITS". A good part of the cost of producing, selling and delivery, involved two very important considerations.

The 1st is **WEIGHT**.

The 2nd is **BULK**. In attempting to solve the weight problem, they resorted to the use of metal, for the bulk of the TUBE, (where the glass was normally the heaviest).

Even then, the next battle, was to cut the Bulk of the Metal Tube. As new Tube Types were formulated, they rec'd the appellation of letters of the Alphabet, which were applied, to indicate their own particular type.

**NOTE:** The DIFFERENCES, might be because of changes in filament voltages/currents, Grid/Focus voltages, Focus deflection arrangement, High voltages, Bulb Shape, Gun type, Deflection Angle, etc. At the time when Flat Screens began to dominate the market, there were literally Hundreds of different Tube Types.

Metal tube types introduced over the years include: a **12"** round; **16"** round; **17"** rectangular; **19"** round; **21"** Rectangular (both GREEN GLASS (more in a minute), and regular lead Glass; and the 30" round {monster}. The **21"** Green Glass (lime glass, instead of lead glass), was tried for a short time, in order to cut down on "SHRINKAGE," (TUBES LOST, IN PART OR WHOLE, to manufacturing problems - it created MORE problems, not less.

New Tubes being manufactured for the first time, received the following designations: The tube size, an alphabetical letter in date order and finally the type of Phosphor used. For example: the 1st **16"** metal, was designated as a "**16A P4**". The Metal cone was approximately **20"** long. The next Tube was called a "**16E P4**". Its Metal cone was approximately **15"** long. The 3rd **16"** metal was labeled a **16G P4**, Its Metal cone was approximately **10"** long.

This reduced bulk, for the T.V. Tube, meant that the T.V. Set would also be less bulky. [Not only, would more T.V. boxes, (containing the CRT), be able to be put in a Trailer, Boxcar or a Sea-Ship's cargo hold], but they could accommodate MORE T.V. Sets, also, {lowering the price per unit, for shipping costs}. **NOTE:** Very often, there would be **2** separate modes, or more, of shipping, depending on origin and destination.

Ex. T.V. Sets/Tubes from the U.S. to Europe, involved shipping by sea, [perhaps even shipping by train, and then finally by truck]. Reverse shipping, was also needed, to return/replace, free of charge, defective/ failed/damaged units, back to the U.S.

So, weight and bulk, of CRT's AND T.V. Sets, were an important part of lowering manufacturing costs. Glass Tube streamlining, was achieved by making the deflection angle (amount of degrees, the **Electron Beam** could be deflected/[bent]). CRT's started out with deflection angles about **60** Degrees and worked their way up thru **90** Degrees, and even **114** Degrees (making for an extremely close front-to-rear relationship for the T.V. Set). The objective, since the early **1950's**, was always to make "**the picture on the wall,**" [which obviously could NOT be a CRT].

**END OF Manufacturing a B & W T V Tube !**

## **SPECIAL MANUFACTURING STEPS, REQUIRED TO PROCESS METAL TUBES, IN ADDITION TO THE NORMAL CRT PROCESSING**

### **PREPARING THE METAL CONE FOR THE FIRST STEP**

The Metal cones are shipped to the Tube Manufacturer, heavily greased up (to prevent any rust or deterioration to occur to the Cone). Therefore, the first step would be to get rid of the heavy coating. The preferred solvent for the type of grease involved, is "Carbon Tetrachloride". **NOTE:** Only as many cones should be cleaned, as would be needed for production, for that day.

### **SANDBLASTING**

A Glass-funnel-like arrangement will be attached to the smaller opening of the Metal cone, while a Glass face-plate will be sealed into the larger part of the metal cone. Therefore both edges are heavily sand-blasted, for **2** reasons.

The **1st** is to make sure that all traces of any substance is removed from those areas.

The **2nd** is, to make an other-wise smooth metal to be roughed-up/ etched, so as to provide thousands of "Valleys" and "Pits", so that the glass has a better chance to adhere to the Metal cone.

**NOTE:** Care should be taken, **NOT** to put your fingers on any of the Sand-blasted areas, as the oils in your skin may interfere with the adhesion/marriage, of the Glass and metal.

### **EXPLANATION OF CO-EFFICIENTS OF EXPANSION PROBLEM & SOLUTION**

Differences of "Co-efficients of expansion", means that one material (in this case (Glass), is slower, to heat/cool, than another material, (in this case metal). Glass does **NOT** expand as much, or as quickly, as metal. To effect a permanent marriage, of the two dis-similar substances, is **NOT** an easy task.

. Research by major glass companies (such as Corning Glass), have come up with a substance, which does **NOT** expand as quickly as metal, but it **DOES** expand, faster than glass. It comes in a powder-like form, and is known as "**FRIT**" GLASS. Placed between the face-plate and the metal, FRIT helps bridge the gap, between the differences of the glass and metal. It is an enormous assistance, to the marriage of the metal to the glass.

Otherwise it would be very difficult to effect the marriage. This marriage is exacerbated by the fact that, is if there is a minute, ["hairline"] crack, such signifies the death of the tube. Even if, the seal is done perfectly, any leak, no matter how minuscule, can **NOT** contain a Vacuum, and will cease to function in a matter of weeks.

At that point, **NOT** only that the customer is allowed a "**NO-COST**" replacement, but the entire bulb must be discarded], even **AFTER** return shipping charges must also be paid by the manufacturer. Ill will, among the ultimate Customer, Distributor, and T.V. Technician (who must replace the CRT, on his time, without additional receipt of money, is a serious problem for the CRT manufacturer.

### **GLASS LATHE, FUSES GLASS CONE, TO METAL CONE.**

The metal cone is attached to the head of a "GLASS-LATHE," which also encloses the open part, of the Metal cone, (so that when air is pumped in, at the lathe-operator's command), the air, can counter-act the force, of the gas-oxygen fires, when the glass is in a pliable, molten state.

First, FRIT glass is APPLIED TO THE GLASS FUNNEL, at the point where the glass is expected to be fused into the Metal Tube. When the fusing operation is completed, then at this point, we have the lower part of the Tube, [including the neck], ready for future use. Needless to say, pre-heating/annealing actions, take longer than the preheating/annealing of Glass-to-Glass seals. Cool down could take as much as 30 minutes.

### **FACEPLATE SEALED INTO METAL TUBE.**

The metal cone, now fitted with the glass cone and neck portion of the tube, was made ready to have the face-plate sealed into the main portion of the Tube. On a specially-designed machine, {more in a minute}, the neck of the tube had an access to air being provided, which could be introduced into the tube, {on command from the operator}, while the unit was in operation. This provided, that when the glass became molten, the face-plate would **not fall** into the metal body, (round or rectangular).

Whatever size or shape, FRIT glass was placed into the rim of the metal tube and the faceplate put on top of the FRIT. The sealing unit had the usual spinning capability, as well as (20) to (40) Jet fires (depending on size of Tube). As usual, the Jets could be moved **up /down** and **left/right**.

To seal in the round tubes, was pretty much straight forward: heat the metal Tube, which in turn heats the FRIT AND the faceplate. As the seal takes place, enough air is pumped into the tube, so as to counter-act the force of gravity, but not too much, so as to make the glass face-plate puff out. That would stretch the glass out too much, so that it would be too thin.

The rectangular Metal Tubes presented a problem for positioning the Jets. There were extra gas/air heating burners (for pre-heating), while the Jets, (that did the work), were **Gas/oxygen** fed. You couldn't set the Jets up to the narrow part of the Metal Tube, because they would be hit by the large part of the tube, when the metal tube spun. This problem was solved, by setting the Jets according to the large part of the tube.

Then, by indexing, jets were continually moved in and out, as the shape changed, (much like a machine gun firing out the front of a propeller-driven airplane, so it would **NOT** shoot its own propeller off). Large, thick asbestos gloves, allowed the tube to be removed from the machine and placed in the obligatory, **cooling/annealing** oven. One single sealing procedure, could take as long as (8) minutes, (including pre-heating/**annealing**).

**When sufficiently cooled, START PROCESSING METAL TUBES, AS IN STEP ONE. "HOW THE TELEVISION TUBE (CRT) IS MANUFACTURED**