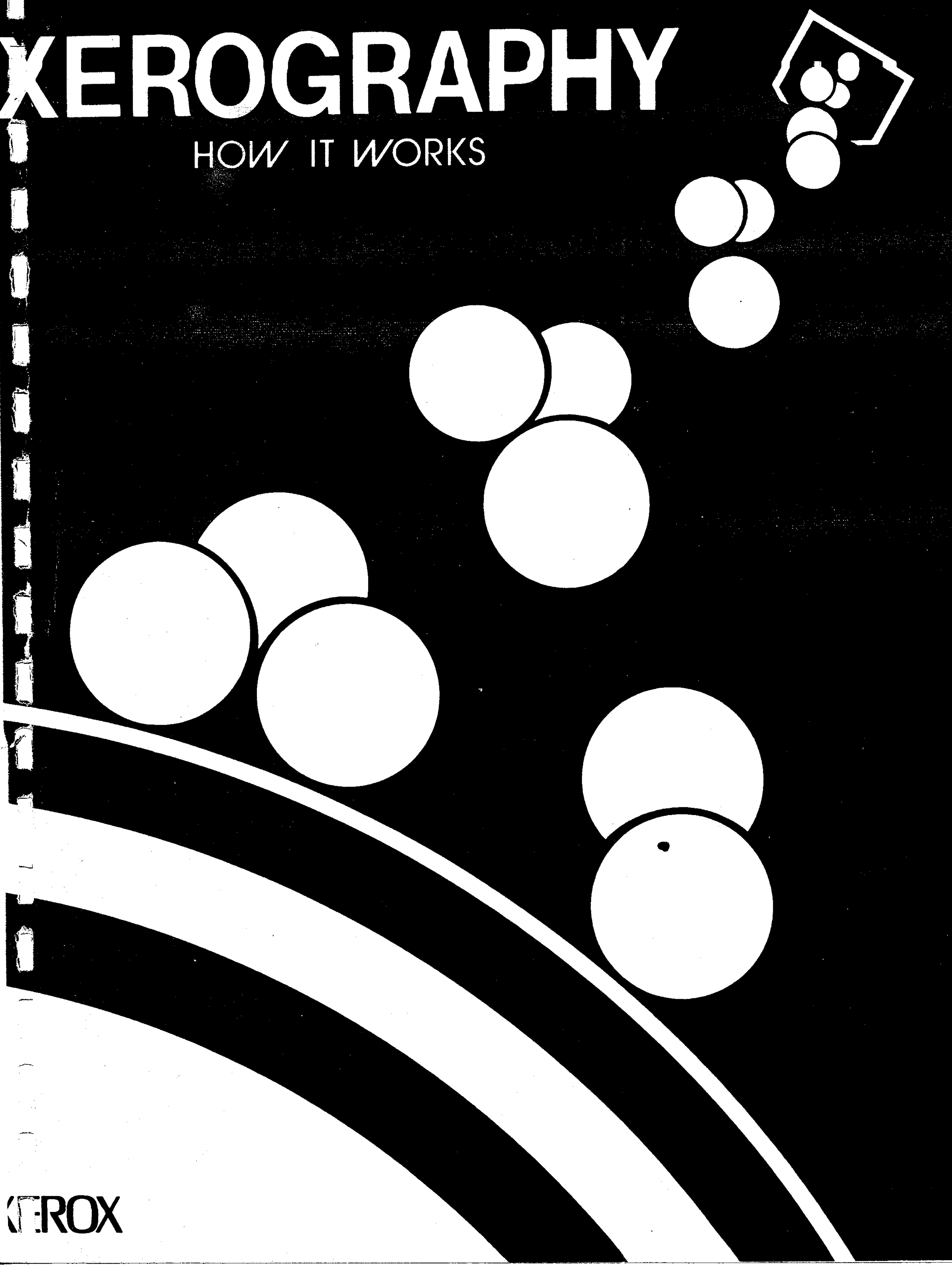
XEROGRAPHY

HOW IT WORKS



XEROX

XEROGRAPHY - HOW IT WORKS

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This document replaces (Orientation to Xerography) 600P80553.

This program is to be used in conjunction with videotape "Xerography ... The Basic Process" (E02178).

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INTRODUCTION

Today's Xerox machine is a highly automated, sophisticated combination of optical mechanical and electrical systems - all based on the science of XEROGRAPHY. This program is intended to present the background information in xerographic sciences which will allow you to understand - HOW IT WORKS.

Upon completion of this program you will be able to list the steps of the xerographic process, identify the machine components most readily associated with that process step, and also become aware of the basic scientific principles involved in xerography.

This booklet is the second part of the system intended to introduce you to XEROGRAPHY. You should already have viewed the videotape "Xerography - The Basic Process." At the end of each section of the program you will find a review. At the end of the program is a composite review. The answers to the section reviews follow immediately after the questions, however; the evaluation of the composite review should be done by your course administrator.

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FIELDS

All matter is comprised of atoms. Atoms are made up of three components; neutrons, protons and electrons. Neutrons are considered neutral in charge, protons positive and electrons negative. If we isolate these components, and consider them as pure positive charge, or pure negative charge point sources, we can begin a brief study of electrostatic fields.

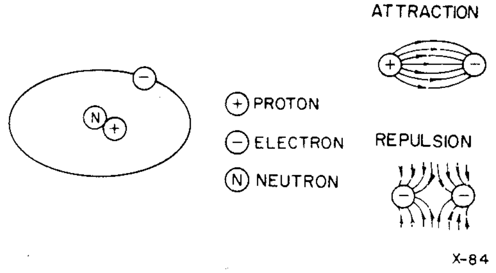


Fig. 1-1.

If you could bring one electron and one proton in close proximity to each other there would be a definite force of attraction between the two components because of their opposite electrical charges. The lines of force (attraction) between them are said to move from the proton toward the electron; thus you see the lines of force depicted that way in Figure 1-1. The strength of the electrostatic force between a single proton and electron would be affected only by the distance between them. The further apart you move the electron from the proton the weaker the electrostatic force becomes. If you could bring two electrons and two protons in close proximity to each other the electrostatic force would change. The increased number of lines of force between the two charges would cause an increase in the strength of the electrostatic force between them. The area between charged pairs, in which we show lines of force, is commonly referred to as the electrostatic field (see Fig. 1-2).

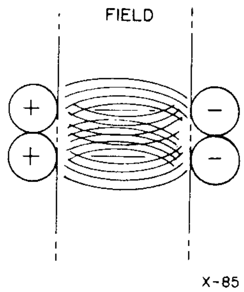


Fig. 1-2.

To review, field strength is affected by two variables, the number of charges (i.e. electrons or protons) and the distance between the charges.

$$\text{Field Strength} \propto \frac{\text{Number of electrons x number of protons}}{\text{Distance apart x distance apart}}$$

Everyone realizes that atoms are the smallest portion of matter we can discuss and that we cannot really simply add or subtract electrons and protons. Atoms combine in nature to form molecules, molecules combine to form particles. Particles are the smallest objects which are visible to the eye. The principles of attraction of opposite charge point sources and repulsion of like charge point sources are generally true for charged particles as well. That is, generally, a positively charged particle will attract a negatively charged particle while a pair of negatively charged particles will repel each other. The same two variables mentioned earlier affect field strength between charged particles. A decrease in distance between the particles increases field strength, an increase in distance decreases field strength. Higher charges increase field strength, lower charges decrease field strength.

You may be asking yourself, "Why all this talk about field strength?" I'm interested in Xerography.

Of the seven steps of Xerography, the five steps of: Charge, Exposure, Development, Transfer, and Cleaning are better understood if you remember the principles of field strength discussed here. Only two xerographic steps: Imaging and Fusing are not affected by the field's strength and shape.

Wait and see! For example, toner, which is generally considered to be of particle size, is the item we must move in the Xerographic process. Fields are how we do it and lines of force are the paths taken by the toner particles. See Figure 1-3.

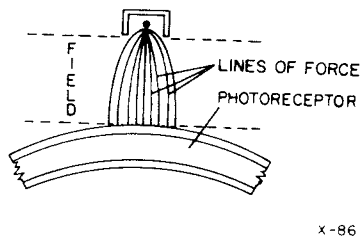


Fig. 1-3.

FIELDS - REVIEW

FIELDS

1. The negatively charged component within an atom is called:

    a. neutron

    b. proton

    c. electron

2. Field strength changes according to what two variables?

    a. ____________________

    b. ____________________

3. Complete the sentence below by crossing out the wrong response.

    Increasing the number of electrical charges (increases, decreases) the strength of the electrostatic field; separating the electrical charges (increases, decreases) the strength of the electrostatic field.

4. What five (5) Xerographic steps are affected by field strength?

    a. ____________________

    b. ____________________

    c. ____________________

    d. ____________________

    e. ____________________

REVIEW ANSWERS

1. electron

2. a. number of charges
   b. distance between charges

3. increasing number increases
   separating decreases

4. a. Charge
   b. Exposure
   c. Development
   d. Transfer
   e. Cleaning

PHOTORECEPTOR

The device within the machine which receives the image is the photoreceptor. It usually consists of an aluminum subtrate (plate, drum or belt) containing a thin layer of the light-sensitive material (photoconductor) selenium. See Figure 2-1.

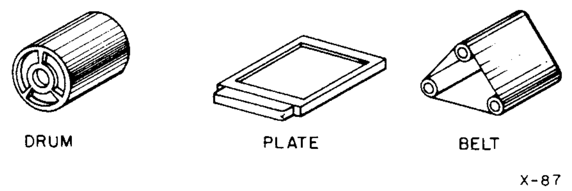


Fig. 2-1.

The shape of the aluminum substrate varies depending on which particular Xerox machine you are considering, however; the photoreceptor's basic construction consists of four distinct layers as follows: (See Fig. 2-2)

1. Substrate
2. Oxide layer
3. Selenium
4. "Trapping" layer

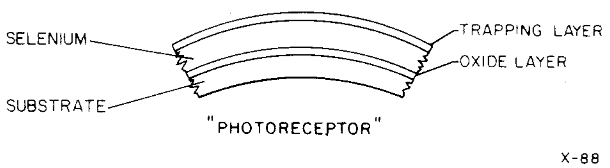


Fig. 2-2.

A bare aluminum alloy substrate is oxidized slightly and then a thin layer of Selenium is evaporated onto the oxide layer. When the outer surface of the Selenium is contacted by the moisture in the air a second oxidation layer is formed. This second oxidation layer, called the trapping layer, is very important to the xerographic process' charging and exposure steps.

PHOTO-CONDUCTION

Taking a closer look at the Selenium and "Trapping" layers will lead us into the somewhat unique properties of Selenium, which caused its selection and use in our equipment. A photoconductor can be defined as follows: a light sensitive material which conducts electricity in the light yet insulates against electrical conduction in the dark (absence of light). That is, a substance whose electrical resistance varies with the amount of light striking it. To understand this property we must review molecular structure and semi-conductor operations.

When several atoms of the same material are combined they form molecules.

Some molecules have many relatively free electrons and are considered conductors. That is, the electrons are free to move within a molecule or between molecules of that material. Materials whose molecules have few free electrons, or materials in which electrons are not free to move between molecules are considered insulators. See Figure 2-3. Materials whose molecules tend to be insulators in their natural state but become conductors when outside energy sources are added are called semi-conductors. See Figure 2-4. Examples of outside energy sources are: heat, light, and electromagnetic radiation.

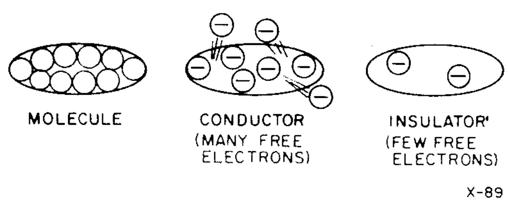


Fig. 2-3.

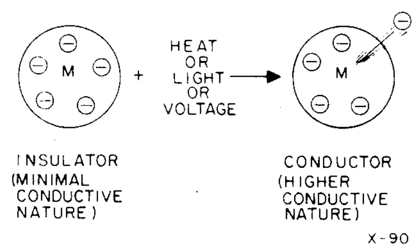


Fig. 2-4.

A semi-conductor which changes its state in the presence of light is called a photoconductor. Selenium is a photoconductor. In the presence of light its molecules become more conductive but when the light is removed, they return to their natural state of minimal conductivity (an insulator). See Fig. 2-5.

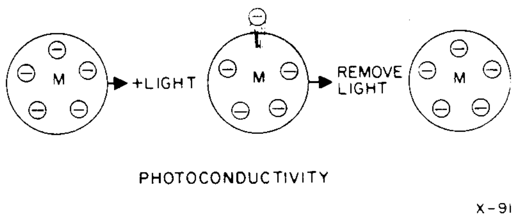


Fig. 2-5.

Let's relate this photoconductive property to using photoreceptor. If we apply a positive charge to th. Selenium, in the dark, it will remain positively charged until exposed to light. That is, the natural state (Selenium in darkness is that of an insulator; therefo the electrons within the Selenium molecules are not free to move towards the photoreceptor surface to neutralize its positive charge. When that same positively charge Selenium photoreceptor is exposed to light, its molecules become highly conductive and its free electrons discharge the Selenium where the light strikes i surface, neutralizing the positive charge in that are Those areas not exposed to light remain non-conductive and retain their positive charge.

PHOTORECEPTOR - REVIEW

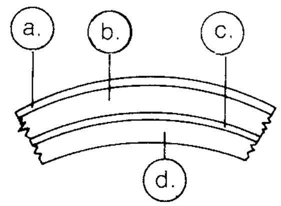
1. Although the shapes of photoreceptors change from machine to machine the construction of all photoreceptors consists of what four (4) layers? Write the names of the four layers shown in the illustration in the spaces provided below.

   a. ______________________

   b. ______________________

   c. ______________________

   d. ______________________



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2. Semi-conductors in their natural state are:

   a. Conductors

   b. Insulators

3. The electrical resistance of a photoreceptor varies directly with the amount of ____________ it receives. Fill in the blank.

4. A photoreceptor, charged positive in the dark, when exposed to light would:

   a. Remain positive

   b. Become negative

   c. Neutralize

   d. Oxidize

REVIEW ANSWERS

1. a. Trapping Layer
   b. Selenium
   c. Oxide Layer
   d. Substrate
2. b.
3. light
4. c.

CHARGE

The charge function can be most simply defined as the application of a positive charge to the photoreceptor surface. This operation must be done in darkness because, as you remember, the Selenium coating on the photoreceptor insulates in the dark and conducts in the light.

The machine components involved in the charging function are:

- photoreceptor
- corotron
- sometimes a scorotron

Considering the make-up of atoms; as described earlier, electrons are considered to have a negative electrical charge and protons a positive electrical charge. Since most atoms exist in a balanced condition (neither negative or positve) most materials also exist in an electrically balanced condition. That is, the number of electrons in each atom or molecule is equal to the number of protons in that same atom or molecule. See Figure 3-1. To cause an object to "become" charged you have to either remove an electron (causing it to become positive) or add an extra electron (causing it to become negative).

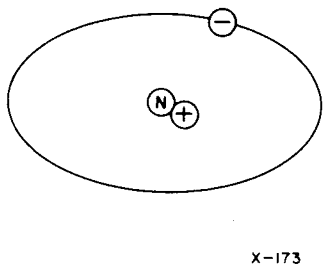

Fig. 3-1.

To cause the photoreceptor surface to become positively charged we have to take away some of its electrons. Let's set the stage for this event. This is accomplished using a DC charge corotron on the photoreceptor in common (everyday) air. The corotron is a fine, approximately .0035 inch diameter, tungsten or platinum wire partially enclosed in a shield. See Figure 3-2. The shield is grounded, the corotron wire is attached to a grounded power supply, and the aluminum substrate of the photoreceptor is grounded. Therefore, we have three easy accesses to electrons: the shield, the corotron wire and the substrate of the photoreceptor.

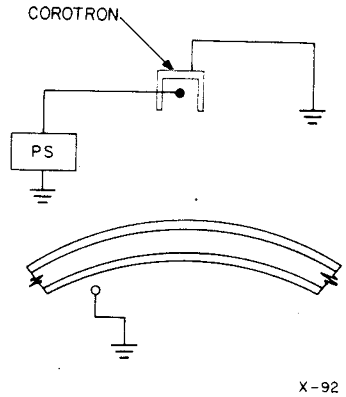

Fig. 3-2.

When the power supply is activated it causes large amounts of electrons to be drawn from the corotron wire and deposited to ground. See Figure 3-3. This leaves the corotron wire charged positive (high potential) and highly desirous of electrons. The difference between the high potential and ground causes the formation of strong electrostatic fields between the corotron wire and the shield, and between the corotron wire and the aluminum substrate of the photoreceptor. See Figure 3-4.

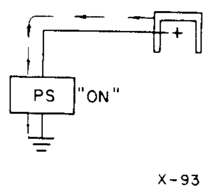

Fig. 3-3.

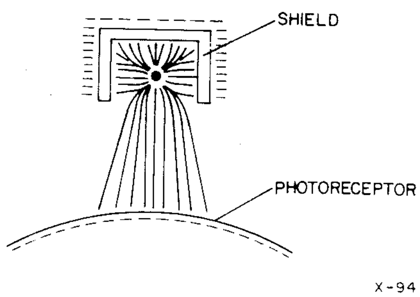

Fig. 3-4.

The most readily available electrons, to satisfy the corotron wires high potential, are in the air nearest the corotron wire; some are free electrons and some are loosely held within water molecules contained in the air. The free electrons in the air are attracted towards the positive corotron wire and on their way bump against water molecules between them and the corotron wire. The water molecules then give off their first electron, bumping still more water molecules and freeing electrons until finally the air provides the corotron wire with the electrons it is seeking. This bumping of electrons and water molecules in the air results in a bluish glow which can be observed around the wire. This bluish glow is called corona, hence the name corotron wire. See Figure 3-5.

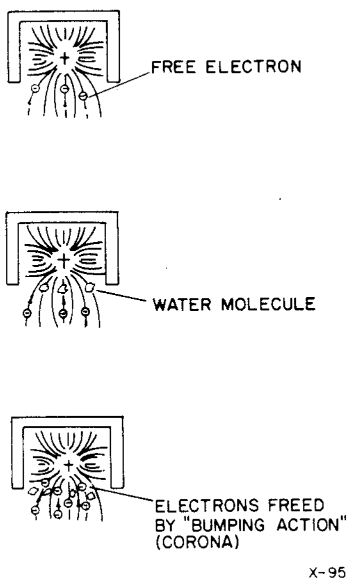

Fig. 3-5.

Remember, most atoms and molecules exist in an electrically balanced state, therefore; when the balanced water molecule in the air gives off an electron it is no longer balanced, it is now positively charged. An electrically imbalanced molecule is called an ION; in this case, we have positive air ions (less electrons than protons). See Figure 3-6.

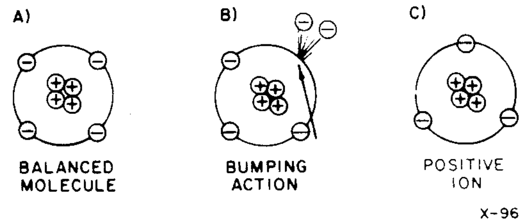

Fig. 3-6.

In fact, we have many, many positive air IONS. These IONS are afforded numerous paths: the lines of force within the fields between the corotron wire and the shield, and the lines of force in the field between the corotron wire and the photoreceptor substrate. IONS will follow each of these paths. Those that travel to the grounded shield will receive an electron from the shield and become balanced again, perhaps to be bumped again and again helping to produce and maintain the corona. See Figure 3-7.

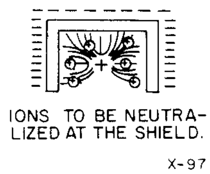

Fig. 3-7.

The positive IONS which are at the bottom of the corotron wire are repelled downward and will be drawn to the photoreceptor by the field between the corotron wire and the photoreceptor substrate. See Figure 3-8.

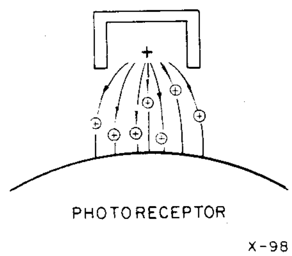

Fig. 3-8.

Looking closely at the field we have established between the corotron wire and the substrate we see the positive air IONS being attracted to the substrate while following the lines of force that exist in that field. See Figure 3-9.

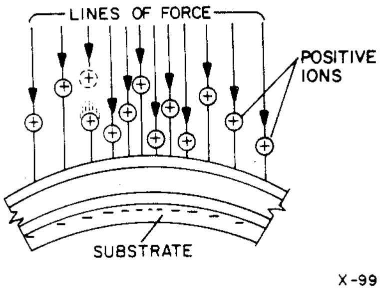

Fig. 3-9.

Looking even closer (Fig. 3-10) we see that the positive air ION is neutralized by receiving an electron from the trapping layer.

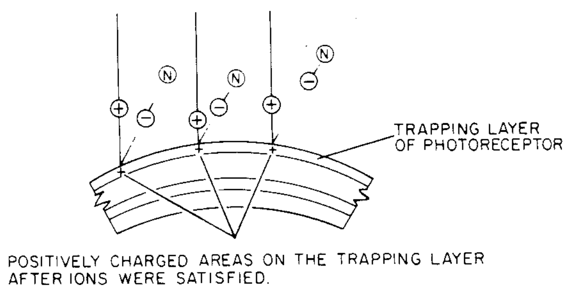

Fig. 3-10.

The trapping layer normally exists in a state of electrical balance. As soon as it gives off electrons to satisfy the positive air IONS the trapping layer "takes on" a positive charge at its surface. Hence when we charge the trapping layer of the photoreceptor we apply a positive charge to the photoreceptor surface, thus performing the CHARGE function. Selenium experiences minimum conductivity in the dark, therefore the trapping layer will hold its positive charge until the Selenium photoconductor is activated by the addition of light. But, we have gotten ahead of ourselves a little. We mentioned earlier the components involved in the charge function are: the corotron, the photoreceptor, and in some instances the "scorotron."

SCOROTRONS

As you would probably guess, scorotrons are used in a manner similar to corotrons to charge the photoreceptor surface. In construction they are multiple wire (usually two) corotrons with a grid between the wire and the photoreceptor. See Figure 3-11. The corotron wires act the same as the single wire charge corotron by producing positive (+) air IONS.

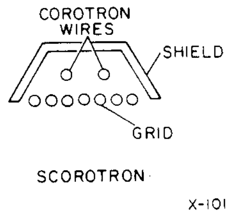

Fig. 3-11.

These IONS are directed towards the photoreceptor surface and travel on the lines of force within the electrostatic field between the scorotron and the photoreceptor substrate. The wire grid between the scorotron and the photoreceptor serves the purpose of controlling and evening out the potential to which the photoreceptor can be charged. The grid is biased to limit the charge potential on the photoreceptor to approximately 900 volts.

For example: as the photoreceptor approaches a potential of 900V the grid offers as good a source of electrons as the photoreceptor. Since the corotron wires are closer to the grid than to the photoreceptor, the photoreceptor charge will be limited to 900 volts.

CHARGE - REVIEW

1. What two machine components are involved in the charge function? <u>Be specific.</u>

   a. ______________________ and

   b. ______________________ .

2. The portion of the photoreceptor which actually receives the charge is the __________ .

   a. trapping layer
   b. selenium layer
   c. oxide layer
   d. substrate

3. The charge left on the photoreceptor after the charge function is completed is (positive/negative).

REVIEW ANSWERS

1. a. Photoreceptor

   b. DC Corotron or Scorotron

2. a

3. positive

IMAGE

The purpose of the imaging function is to transport a reflected image of the original document to the photoreceptor surface.

The machine components involved in the imaging function are:

- platen glass
- exposure lamps
- mirrors
- lens
- exposure slit

The original document, often called the "object" is placed upon a flat or curved platen glass. The reason for the glass is to help in registering the paper and also to support it so that it doesn't bend or warp causing out of focus areas on the copies being made. See Figure 4-1.

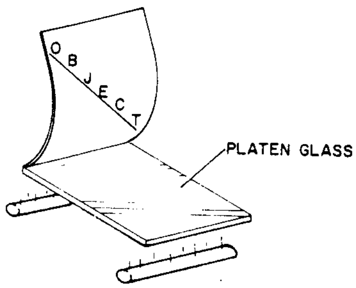

Fig. 4-1.

Exposure lamps are used to illuminate the "object" allowing a reflected image to be sent to the remainder of the optical system. The object (original document) usually consists of areas that are blank and areas of illustrations or typed text, just as this page is a combination of blank areas and typed "image" areas. The light from the exposure lamps is reflected from the blank (non-image) areas of the object but it is absorbed by the image areas. See Figure 4-2.

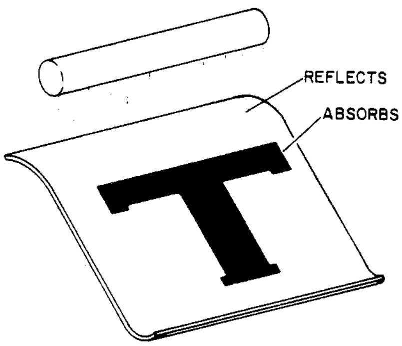

Fig. 4-2.

The idea of light being absorbed by dark areas and reflected by light areas can easily be observed by touching automobiles of different colors on a sunny day. A white or light colored auto does not feel as hot as a black or dark colored auto. The dark color absorbs the light and is hotter to the touch than the light color.

The light that is reflected from the object travels away from all points in straight lines. We now need to collect all of this reflected light and converge it into an exact copy of the object. These two tasks are performed by a lens: gathering light and converging it into an image. Lens design is a very specialized profession and will not be part of this presentation. Suffice to say that lenses are either simple (one element) or complex (two or more elements) in construction. Xerox equipment uses complex lenses but in this module all lenses will be depicted as simple lenses. See Figure 4-3. The line passing through the center of a lens perpendicular to its surface is called its optical centerline or optical axis. See Figure 4-4.

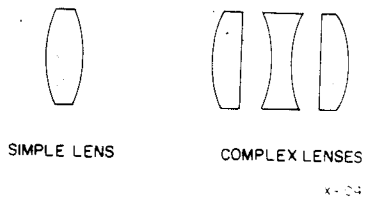

Fig. 4-3.

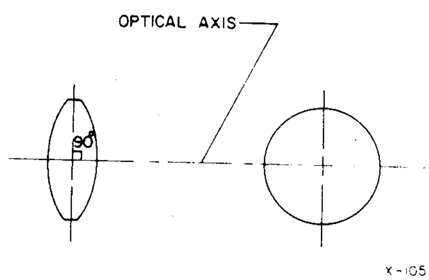

Fig. 4-4.

Reflected light from the object travels in all directions, sometimes parallel to the optical axis of the lens and sometimes at odd angles to the optical axis. As we have said, the lens gathers much of this light and converges it into an exact copy of the object. This exact copy is not only upside down (as you can see) (see Fig. 4-5) but it is opposite in every way to the object. Top and bottom reversed and left and right reversed. This reversed image is called the REAL image.

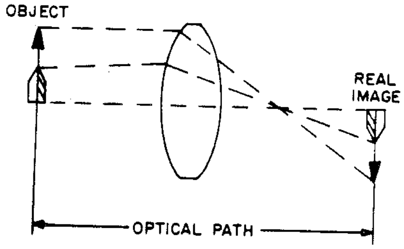

Fig. 4-5.

The length of the optical path (from the object to where the REAL image is projected onto the photoreceptor) is determined by the curvature of the lens. On the various Xerox machines used today optical paths vary from 17 to 54 inches in length. The "typical" optical path would be about 40 inches. That means that the object should be approximately 40 inches from the photoreceptor. For one to one reproductions (copy same size as original) on this "typical" machine the lens would ideally be equally spaced between the platen glass and the photoreceptor and there would have to be a clear, unobstructed path of 40 inches between the platen glass and the photoreceptor. See Figure 4-6. Machines simply aren't designed that way; that is, we seldom have the luxury of a vertical optical path or the 40-inch unobstructed path, so we bend or fold the optical path with mirrors.

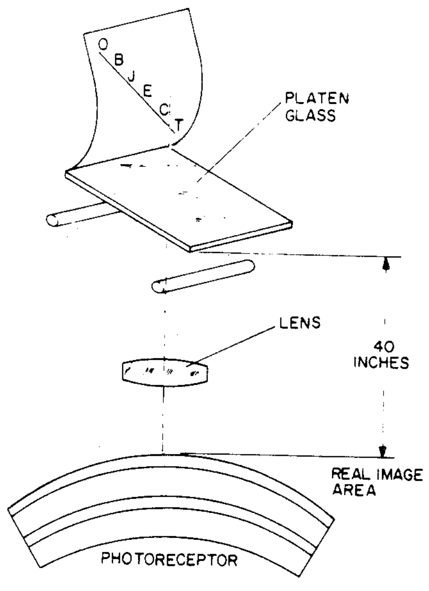

Fig. 4-6.

The distance between the object and the photoreceptor in Figure 4-7 is the same, 40 inches but the opti l path is folded to meet machine size restraints. In r "typical" machine example, it is now conceivable that the vertical distance between the object and the photoreceptor is 20 inches instead of the original 0 inches.

NOTE: This is only an example of typical optical path length and is shown to illustrate the use of mirrors to f d the optical path.

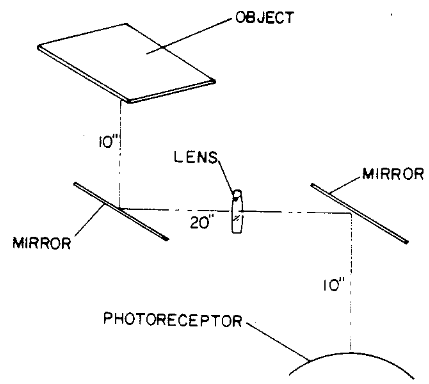

Fig. 4-7.

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One thing should be mentioned about the mirrors used in the optical path of any Xerox equipment. These mirrors are front surface mirrors and not like the mirrors you have at home. That is, the reflective surface is on top of the glass not on the back side of the glass. This is done to avoid the reflection of images off the front glass which could cause double imaging. See Figure 4-8. It also causes a handling problem, front surface mirrors must be handled very carefully while cleaning them or while working around them.

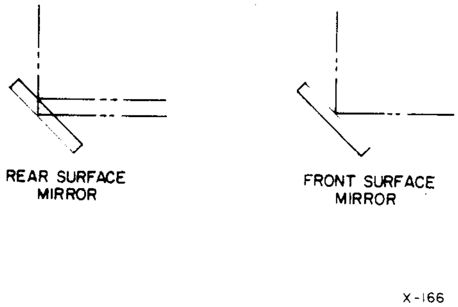


Fig. 4-8.

Our image has travelled from the object through the optical path or mirrors and a lens and is now about to contact the photoreceptor surface. When the light actually contacts the photoreceptor you are in the next step in the process (exposure) however, the last component the light passes through before exposure is called an exposure slit. The exposure slit is positioned between the last mirror and the photoreceptor surface, and serves these three purposes:

1. Limits the area of the photoreceptor surface that the REAL image is projected on.
2. Controls the exposure time (length of time the photoreceptor is exposed to the image).
3. Reduces optical noise (light not part of the REAL image).

The photoreceptor in most xerographic devices is a drum, therefore the surface is cylindrical. To acquire a focused image on the image plane or photoreceptor surface the optical axis of the image and the image plane must be at 90° to the optical axis. As you move away from the tangent point the light does not strike the surface at 90° to the optical axis. If you move far enough from the axis the image would be out of focus, therefore, we place an exposure slit in front of the photoreceptor to limit the surface area that the REAL image is projected on. See Figure 4-9.

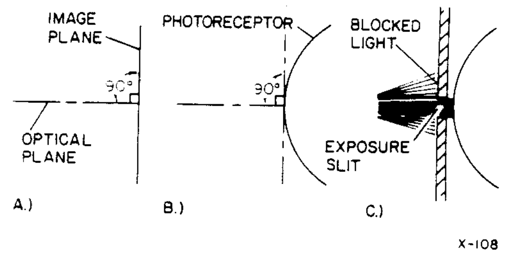


Fig. 4-9.

A second use of the exposure slit is to control exposure time. Since the light being presented to the exposure slit is constant, and the photoreceptor rotation is constant, changing the size of the exposure slit changes the amount of time the light contacts the photoreceptor. A narrow exposure slit allows light from a given point of the object to reach the photoreceptor surface for a shorter time than a wider exposure slit. If the rotation speed were the same and all we changed was the size of the exposure slit, say from 1/4-inch to 1/2-inch each point on the surface of the photoreceptor would be exposed to light for twice the amount of time. This would have the effect of allowing more time for the charged photoreceptor to have its charge dissipated, (exposure, step three in the xerographic process). Unfortunately, it also allows more unwanted light (optical noise) to reach the photoreceptor surface. See Figure 4-10.

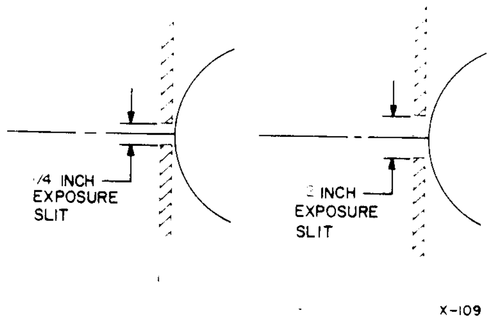


Fig. 4-10.

Optical noise is defined as unwanted light rays which are reflected from surfaces or machine components which pass thru the lens and towards the photoreceptor. Typical sources of optical noise might be dirt on the platen glass, polished surfaces or hardware around the platen glass area, reflecting unwanted light into the REAL image. See Figure 4-11.

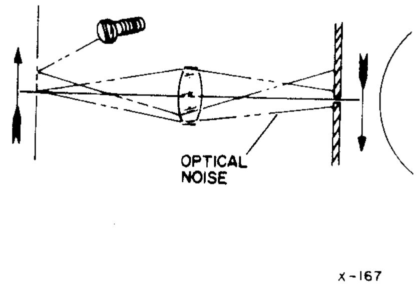


Fig. 4-11.

As you can see from the illustration above, the light which was reflected from the platen glass and the hardware in the platen glass area are blocked from the photoreceptor surface by the exposure slit. This unwanted light would have the effect of weakening the REAL image by discharging the photoreceptor in the image area of the object being copied.

Let's review the imaging function, light from the exposure lamps is reflected from the original document (object) and is reflected by mirrors through a lens and exposure slit onto the photoreceptor. As we said, the second the light hits the photoreceptor surface you are in the exposure step - the next module in this program. See Figure 4-12.

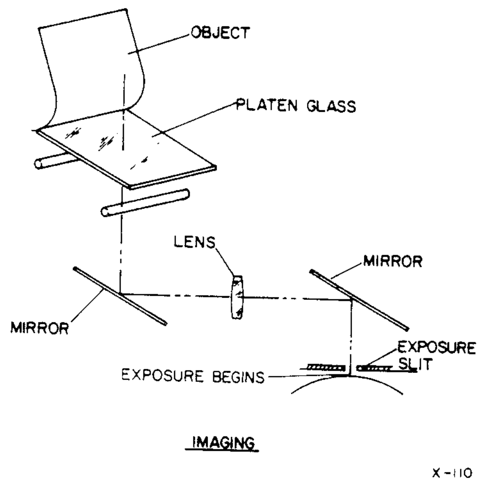


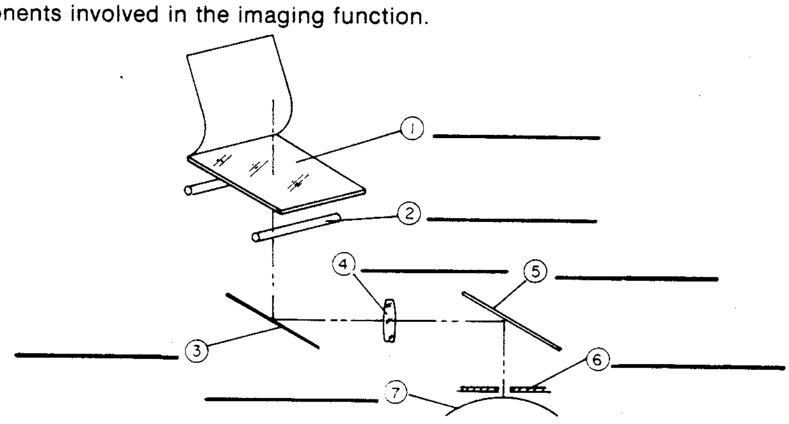
Fig. 4-12.

IMAGE - REVIEW

1. Match the components listed on the left with the statement on the right which best describes its function within the imaging process. Enter the appropriate statement number in the space provided to the left of the component name.

___ platen glass	1. folds the optical path
___ exposure lamps	2. limits the amount of the REAL image projected upon the photoreceptor surface
___ mirrors	3. supplies light
___ lens	4. holds object in place for registration purposes
___ exposure slit	5. gathers and converges light into REAL image
___ photoreceptor	6. charges photoreceptor with uniform positive charge
	7. receives image from optical system
	8. gives off electrons satisfying positive air ions nearest the corotron wire

2. In the illustration below, label the various machine components involved in the imaging function.



X-169

3. Unwanted light which is reflected from machine components within the optical area is called ______________ .

REVIEW ANSWERS

1. _4_ platen glass
   _3_ exposure lamps
   _1_ mirrors
   _5_ lens
   _2_ exposure slit
   _7_ photoreceptor

2. 1. platen glass
   2. exposure lamps
   3. mirror
   4. lens
   5. mirror
   6. exposure slit
   7. photoreceptor

3. optical noise

EXPOSURE

Once you have established a correctly sized, properly focused image, the next step is to place that image onto the photoreceptor. This is the only machine component directly involved in the Exposure function. The lens and mirror combination described in the imaging function only get the image to the photoreceptor. What happens now is that the charged photoreceptor is exposed to light. The instant that the light touches the Selenium layer of the photoreceptor it begins to discharge the positive charge left in the photoreceptor trapping layer. Remember, the trapping layer has been charged by the corotron wire to a uniform positive charge. See Figure 5-1. In the dark, the Selenium acts as an insulator and does not discharge the positively charged trapping layer.

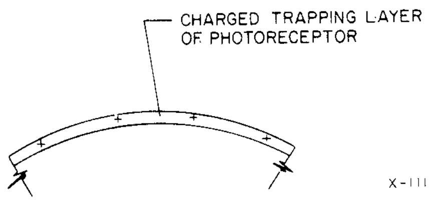


Fig. 5-1.

When light hits the photoreceptor and passes through the trapping layer into the Selenium layer photoconductivity takes place. Setting the stage again, we have to establish the existance of fields between the electrons in the substrate and the postively charged trapping layer. There is a force of attraction but the space between the two charges consisting of Selenium acts as a barrier - as long as there is no light. See Figure 5-2.

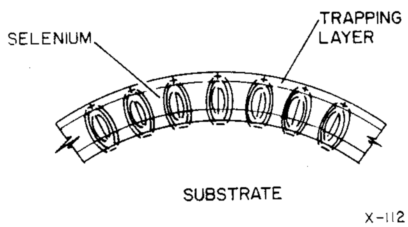


Fig. 5-2.

When the charged photoreceptor is exposed to light rays, photo-conductivity occurs. In the dark, Selenium molecules have very few free electrons, thus in the dark we consider Selenium an insulator. When Selenium molecules are exposed to light rays (see Fig. 5-3) they become more conductive, actually allowing some of their electrons to move between molecules. When a light ray strikes a Selenium molecule on the top surface of the Selenium layer it frees an electron. This electron is drawn towards the positive charge in the trapping layer and migrates (travels) in that direction along the lines of force between the charged trapping layer and the substrate. See Figure 5.4 This leaves a shortage of one electron in the area just vacated (a hole), this shortage (hole) is then satisifed by an electron from a molecule just beneath it. This procedure repeats itself until you reach the surface of the lower oxide layer. See Figure 5-5.

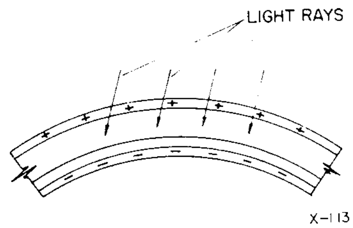


Fig. 5-3.

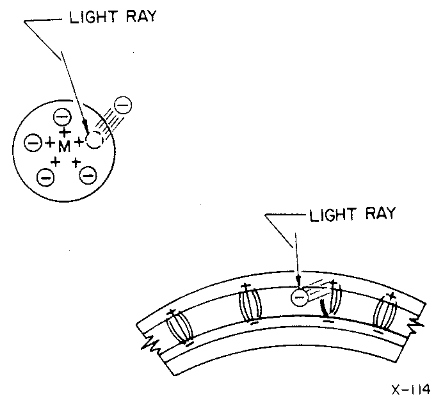


Fig. 5-4.

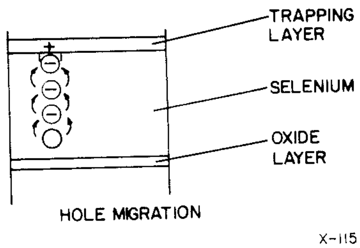


Fig. 5-5.

These molecules are present in an unbalanced electrical state-they are short one electron of being balanced. The constant moving of an electron shortage (hole) down the layer of Selenium has been called "hole migration". You may hear this term used in discussions on Xerography later on.

Let's talk about the fields existing as this electron hole moves down through the Selenium layer. In the discussion on fields we learned that two things affect the strength of electrostatic fields: the number of opposite charges present, and the distance between those charges. Question: Is the field between the positive Selenium molecules and the electron in the substrate increasing or decreasing as they get closer together? Use your memory, don't look it up. The field gets stronger as the opposite charges get closer together. You finally reach a point where the charges are so close together and the attractive force is so strong that even though there is an oxide layer between the Selenium and the substrate, the electron in the substrate actually jumps over the oxide layer and balances the Selenium molecules. See Figure 5-6. Since the substrate is grounded its electron deficiencies can be satisfied from ground. This is happening in all areas where light strikes the Selenium but is not happening where light does not strike the Selenium. Light is reflected from only the background areas on the object. So, what actually happens in the Expose function is that we discharge the photoreceptor in areas corresponding with the non-image areas of the original document. Since the charged photoreceptor had a uniform positive charge on it, exposing removes the positive charge due to the process of photo-conductivity, leaving it charged only in the image area of the original. This charged image is often called a "latent image." It exists as a positively charged area on the photoreceptor but cannot be seen. See Figure 5-7. In order for the latent image to be seen it must be developed, which is the next function to be discussed.

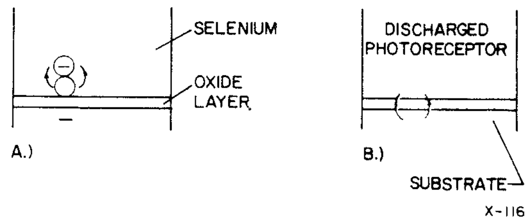


Fig. 5-6.

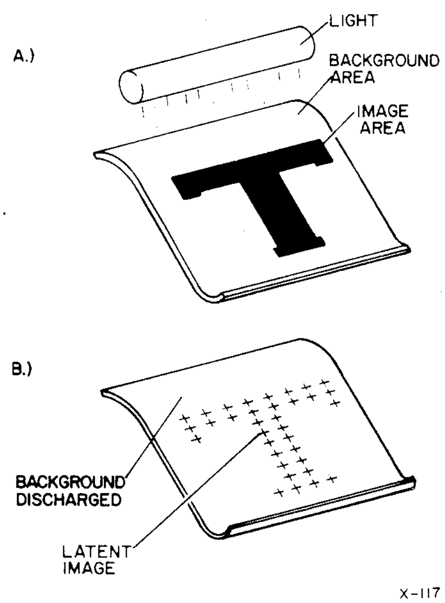


Fig. 5-7.

EXPOSURE - REVIEW

1. The exposing function takes place at what instance in time.
   a. When the exposure lamp is turned on.
   b. When the exposure slit is opened.
   c. When the projected light reaches the photoreceptor surface.

2. Before exposure, the charged photoreceptor has a (positive/negative) charge, after exposure the photoreceptor surface areas touched by light become (positive, negative, or neutral) in charge.

3. The name given to the invisible, charged, image on the photoreceptor surface after the exposure function is the ________ image.

REVIEW ANSWERS

1. c
2. before exposure - positive
   after exposure - neutral
3. latent

In up-hill cascading the developer housing operates almost exactly the same, the major difference being that the photoreceptor surface and developer are going in opposite directions when the developer contacts the photoreceptor. Hence the term "up-hill' development. Actually, the developer is cascaded down but the photoreceptor going in the opposite direction has been described as having the effect of cascading the developer "up-hill". See Figure 6-8.

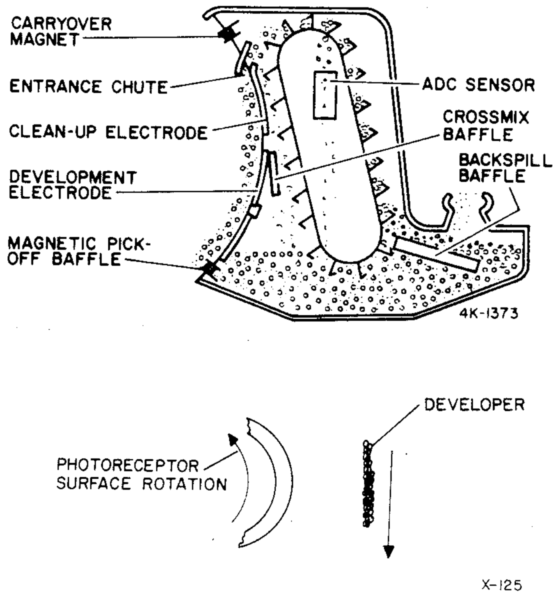


Fig. 6-8.

MAG BRUSH DEVELOPMENT

The term mag brush is used to describe the third prevalent method of development. The name is a shortened version of Magnetic Brush Development.

Instead of cascading the developer over the photoreceptor surface this technique "brushes" the developer across the photoreceptor. The technique used to produce this brush uses magnetic lines of force. I'm sure you remember discussing the lines of force that exist between a north and south pole of two magnets in school. See Figure 6-9. When the north pole of one magnet is brought into close proximity with the south pole of another magnet they are drawn towards each other (attracted to each other). When two north or south poles are brought near each other the magnets don't want to come together. They repel each other. In high school you probably did some experiments with magnets in which you placed a piece of paper over these magnets and poured iron filings over the paper to see the lines of force between the magnets. When the paper was tapped slightly the iron filings formed lines between the two magnets something like Figure 6-10. The Mag Brush Development method uses these lines of force to produce its brush. The magnets discussed above have their poles at the ends. Special magnets are used in "mag brush" development which have their poles on the side rather than the ends of the magnet. Lines of force around this magnet or a pair of these magnets would look like Figure 6-11.

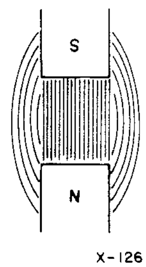


Fig. 6-9.

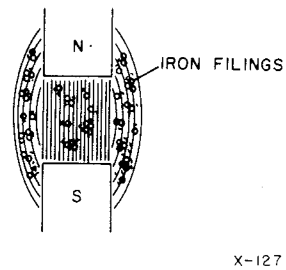


Fig. 6-10.

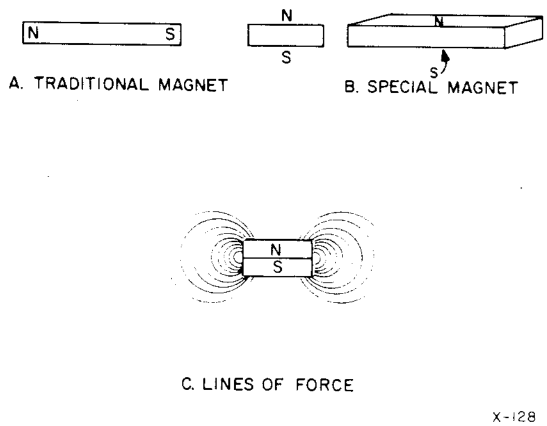


Fig. 6-11.

These magnets are mounted on a keeper together with a set of pick-up magnets. The assembly is now placed within an aluminum cylinder, thus forming the center of the magnetic brush roll. See Figure 6-12. (The magnetic lines of force around this assembly are depicted in Figure 6-14.) The Mag Brush assembly is mounted in the developer housing so that the aluminum cylinder is in contact with the developer (Fig. 6-13). The pick-up magnets attract or pick up the developer (steel shot and toner) and start its movement towards the photoreceptor surface. The developer lines up along the magnetic lines of force in an arrangement similar to Figure 6-14. The lines of force form a shape similar to the brush in the development zone. The developer lines up in a form similar to a brush, thus the name "mag brush." The developer "bristles" are trimmed to proper length and allowed to gently roll across the surface of the photoreceptor brushing it onto the latent image. In each of the three development methods just discussed we indicated that the developer is either cascaded over or brushed across the photoreceptor. Remember, the function of the development step is to cover the latent image on the photoreceptor left by the expose step with visible (negatively charged) toner particles.

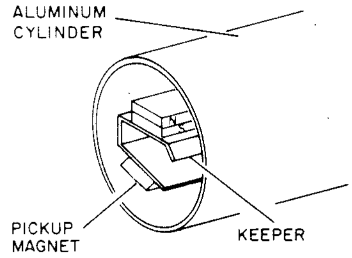


Fig. 6-12.

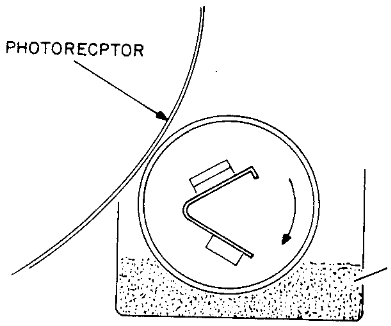
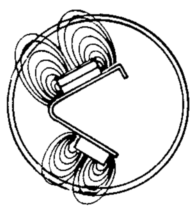
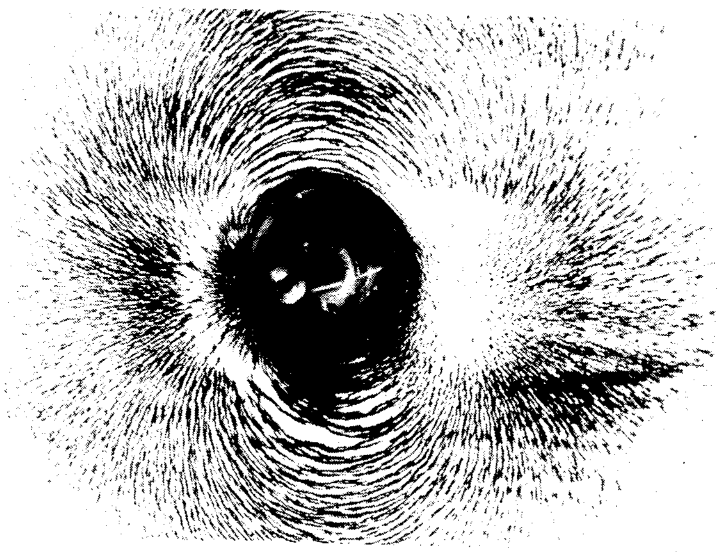


Fig. 6-13. X-130



A. LINES OF FORCE



B. "BRISTLE" FORMATION X-160P

Fig. 6-14.

DEVELOPMENT - REVIEW

1. What is the purpose of the development function? ____________________
____
2. The combination of toner and carrier beads is called __________. When the toner particles and carrier beads come into contact with each other, the toner becomes __________ in charge and the carrier bead __________.
3. List the three prevalent methods of development used in Xerox machines today.
   a. ____________________
   b. ____________________
   c. ____________________

REVIEW ANSWERS

1. To make the invisible latent image visible by placing toner upon it.
2. developer
   negative
   positive
3. cascade
   up-hill cascade
   magnetic brush (mag brush)

TRANSFER

In simplest form transfer is described as the passing of the developed image from the photoreceptor surface to the paper.

The machine components involved in the transfer function are:

- photoreceptor
- DC corotron

Also presented as part of the transfer function are the machine components sometimes used immediately preceding and following transfer, a "pre-transfer" corotron and paper removal (detack) components.

The elements needed as input to the transfer step are the paper and the developed image on the phtoreceptor. The developed image and paper need to be prepared for the transfer step. The strength of the field holding the toner image to the photoreceptor must be reduced and the paper must be charged positively to attract the toner from the photoreceptor.

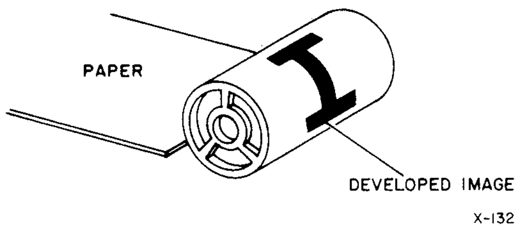


Fig. 7-1.

PRE-TRANSFER

As mentioned, the strength of the field holding the toner image to the photoreceptor must be reduced. This is accomplished with a corotron, usually an AC corotron. A DC corotron is used in some equipment, but an AC pre-transfer corotron is used most frequently. Looking closely at the developed image we see: negatively charged toner particles held in place by the electrostatic field between the photoreceptor and the toner particles, a positively charged trapping layer and a negatively charged substrate within the photoreceptor. There are also occasional areas on the photoreceptor which contain isolated particles of toner in the background areas held in place by a weaker electrostatic field, see Figure 7-2. What we want to do is neutrailze the charge on the toner particles in the background areas and reduce the field strength in the image areas. Both of these tasks can be accomplished with a positively biased AC corotron.

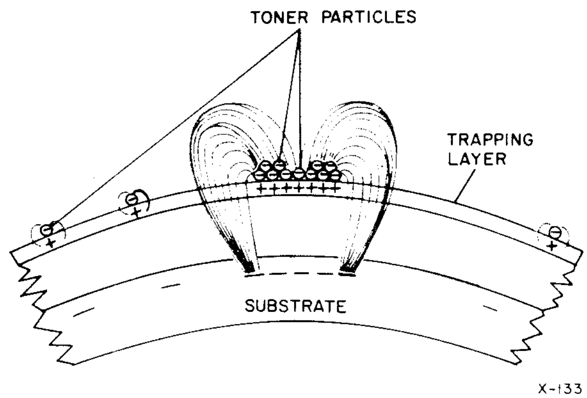


Fig. 7-2.

Reviewing the charge function briefly, we recall that in the charge function the corotron took free electrons from the air nearest itself and also from the water molecules within the air, thereby forming (+) positive ions which followed the lines of force in the electrostatic field and eventually reached the photoreceptor surface. The positive voltage required to cause this ionization is approximately 4500 VDC. (Since the charge corotron is a DC corotron, it produced a steady stream of (+) positive air ions.)

AC COROTRON THEORY

An AC corotron has a voltage applied to its wire which alternates between positive and negative. The positive voltage required to cause ionization is +4500 VAC, therefore, the AC corotron wire must be supplied with at least 4500 VAC. The generally used value is in excess of 5000 VAC. The AC voltage supplied to the corotron can be depicted as shown. In each cycle it receives +5000 V and -5000 V. The positive and negative portions of this cycle are often referred to as half cycles: the positive half cycle and the negative half cycle. See Figure 7-3.

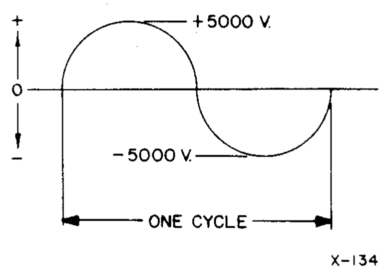
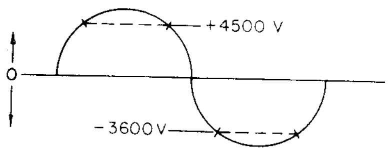


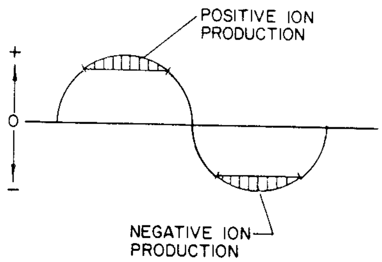
Fig. 7-3.

When the voltage applied in the positive half cycle reaches +4500V, the air around the corotron wire ionizes causing positive ion production. When the voltage applied in the negative half cycle reaches -3600V, the air around the corotron wire ionizes causing negative ion production. Since these values are the minimum voltage requirements to cause ionization, and since they are not equally distant from the 0 point, negative ions are produced for a longer period of time. See Figures 7-4 and 7-5.



X-135

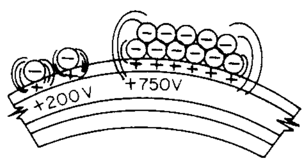
Fig. 7-4.



X-136

Fig. 7-5.

If this corotron were allowed to operate in an unbiased condition, the positive and negative ions would neutralize each other and only the excess negative ions would go unsatisfied. Let's look closer at the entire area again. The image area is positively charged to approximately +750V and the background area to approximately +200V. Therefore there is a strong positive field in the area of the image.

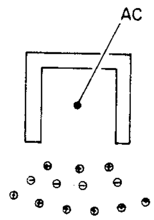


X-137

Fig. 7-6.

Although not completely correct, the results of the AC corotron are depicted as waves or "clouds" of ions alternating in charge from positive to negative. Each half cycle the charge of the ions change.

When the corotron voltage is in its (+) positive half cycle two electrostatic fields are established: one between the corotron wire and the shield and one between the corotron wire and the substrate of the photoreceptor. Remember, there already exists a strong positive field (+750V) in the image areas of the trapping layer. The positive ions which are produced travel on the lines of force of these fields away from the corotron wire. When the corotron voltage changes to its (-) negative half cycle the corotron wire adds negative ions to the air nearest to itself. These ions are attracted by four electrostatic fields; the shield-corotron field, the substrate-corotron field, a field between the new negative ions and the positive ions produced in the positive half cycle, and the +750V field in the image areas of the trapping layer. See Figures 7-7 and 7-8.



X-138

Fig. 7-7.

X-139

Fig. 7-8.

Many of these negative ions contact the positive ions just produced and are neutrailzed. Still others travel towards the substrate. Also, as we have learned, the negative ion production time is longer, therefore more negative ions are produced. The additional negative ions which go unneutralized are finally attracted by the positive field in the image areas of the trapping layer (image 750V and background 200V). This would cause a large quantity of negative ions to be attracted to the image area to neutralize the attractive force in the image area but, it would also cause negative ions to be attracted to the background areas. Eventually the ions would coat the photoreceptor surface with a negative charge. This charge would cause problems in the next charge cycle of the photoreceptor. To minimize this effect, the voltage applied to the AC corotron is biased with approximately +450 VDC. This has the effect of evening out the positive and negative ionization production times. The +450 VDC becomes the base of the 5000 VAC applied to the corotron wire. This causes the positive half cycle to reach +4500 V sooner. (Remember +4500 V is the point at which the positive ionization begins.) It also has the effect of increasing the time required to reach -3600V (the negative ionization point).

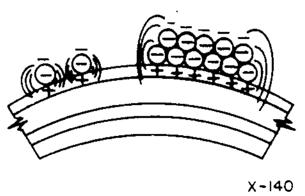


Fig. 7-9.

The net results of these two changes in ionization time is that the number of negative and positive ions produced becomes equal (see Fig. 7-10). Since fewer negative ions reach the photoreceptor surface, fewer negative ions are attracted to the background electrostatic fields and the problem of coating the photoreceptor with negative ions is eliminated. The negative ions that are produced are attracted by the strong electrostatic field in the image area and neutralize some of the positive charge in the image area. This has the effect of reducing the strength of the field. (Remember, field strength is affected by the number of charges present and also the distance between those charges.) Thus, we have prepared the developed image for transfer by reducing the electrostatic field holding the toner. See Figure 7-11.

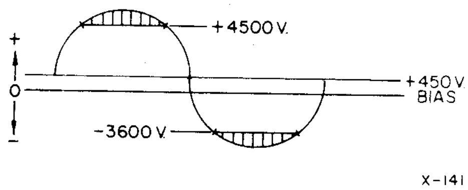


Fig. 7-10.

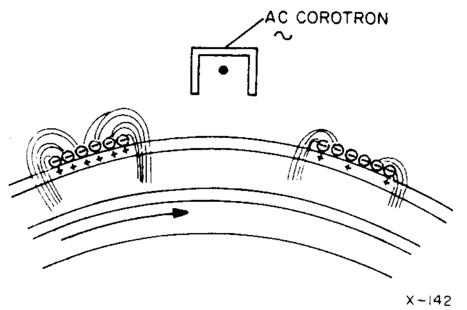


Fig. 7-11.

TRANSFER

The transfer of the developed image is accomplished when the developed image is transferred to the paper. Just prior to the time the paper contacts the photoreceptor it passes under a DC+ corotron which saturates the paper fibers with positive (+) ions. See Figures 7-12 and 7-13.

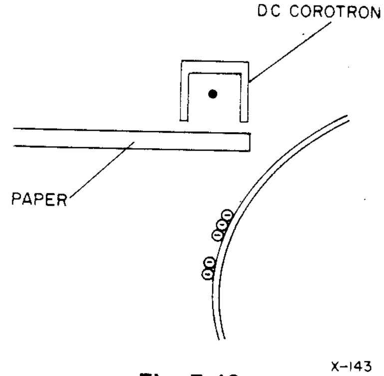


Fig. 7-12.

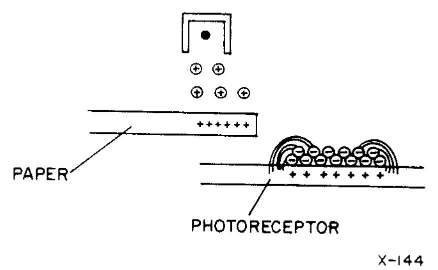


Fig. 7-13.

TRANSFER

This corotron acts in exactly the same manner as the charge corotron, but in this instance the positive air ions do not reach the photoreceptor surface, they are trapped within the paper. The positively charged paper is now strongly attracted to the electrons in the substrate causing all of the air between the paper and photoreceptor surface to be removed. See Figure 7-14. (This is what is referred to as "tacking" the paper to the photoreceptor.) The paper is now closer to the top toner particles and a stronger attractive field exists between them and the photoreceptor. These toner particles are then attracted to the paper. When the paper is removed from the photoreceptor surface the toner remains attracted to the paper and leaves the photoreceptor surface. Not all of the toner leaves the photoreceptor. See Figure 7-15. The toner remaining is called the residual image and must be removed in the clean step. The clean function is described in detail in module 9 of this program.

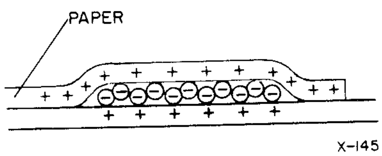


Fig. 7-14.

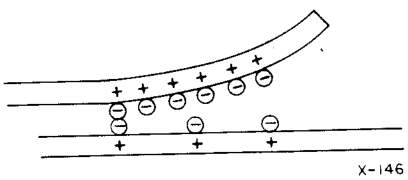


Fig. 7-15.

PAPER REMOVAL

Removing the paper from the photoreceptor surface is the next step in the transfer process. There are two prevalent methods of removing the paper edge from the photoreceptor, stripping the paper edge off with a "stripper finger" or blowing the paper edge off with a "puffer." The "stripper finger" method employs a device which rides on or near the photoreceptor surface and actually strips the lead edge of the paper off.

The puffer method employs the use of small jets of air which actually blow the lead edge of the paper from the drum with a slight puff of air. See Figure 7-16.

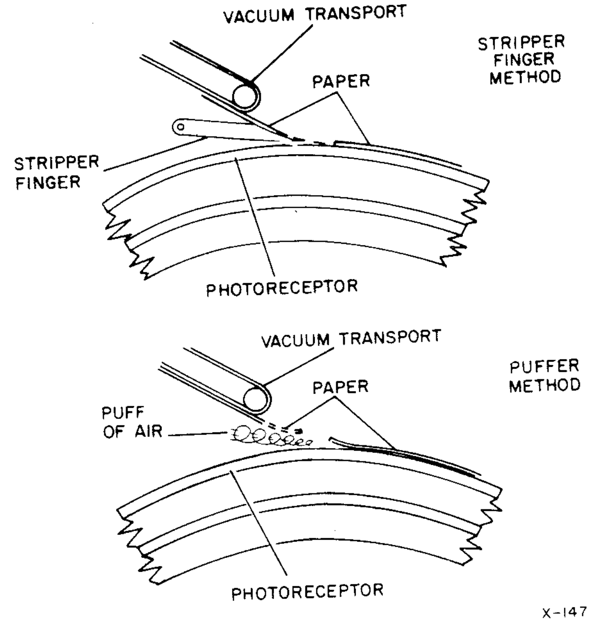


Fig. 7-16.

Once the lead edge of the paper has been removed from the photoreceptor the paper is transported by a vacuum transport system and guided to the fusing ar of the machine. See Figure 7-17.

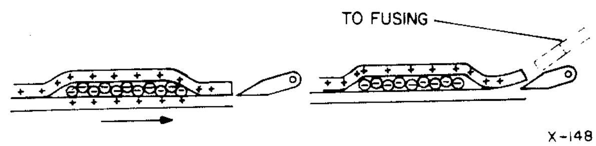


Fig. 7-17.

DETACK COROTRON

The last but perhaps most important component involved in the transfer process is the detack corotron. The detack corotron is another positively biased corotron which performs the task of reducing the charge potential on the paper to aid in peeling it away from the photoreceptor surface. See Figure 7-18.

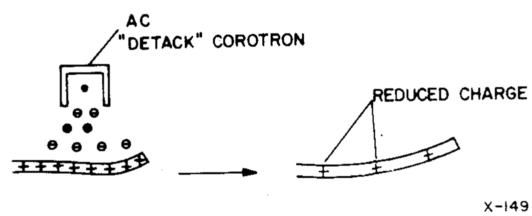


Fig. 7-18.

After the paper edge is started in a direction away from the photoreceptor, the charge potential at the point of separation increases making it very difficult to remove the paper. To eliminate this problem, the paper is passed under another biased AC corotron. This corotron, like the pre-transfer corotron, allows a flow of negative (-) ions to reach the paper and reduce the charge within the paper. The extremely high positive potential which is caused by removing the paper from the photoreceptor surface has the effect of causing the toner particles to move toward (migrate to) the point of separation, this can cause the copies image to be somewhat distorted. The reduction of the positive charge within the paper has the extra benefit of reducing toner migration. Therefore, the detack corotron does two important tasks, it reduces the charge on the paper to aid in removing the paper from the photoreceptor, and it minimizes the amount of toner migration which occurs at the point of transfer.

We have now completed the transfer function, and are now ready for the fuse function and the clean function. The paper now has a loosely held toner image on it which must be made more permanent and, the photoreceptor surface has a residual image on it which must be cleaned before it is ready to be used again.

Let's review what happened in this function:

- The developed image was passed under an AC pre-transfer corotron in order to reduce the electrostatic field holding the toner image to the photoreceptor.
- The paper was passed under a DC corotron to charge the paper with a high positive charge allowing it to be strongly attracted to the negative substrate of the photoreceptor.
- The paper was passed under an AC Detack Corotron which reduced the positive charge on the paper and aided in removing the paper from the photoreceptor.
- The paper edge was then either stripped or puffed from the photoreceptor surface.
- The paper was then trasported to the fusing area for permanent bonding.

TRANSFER - REVIEW

1. The purpose of the transfer function is to:
   a. transfer the charge to the paper
   b. transfer the charge to the photoreceptor
   c. transfer the image to the paper
   d. transfer the paper to the fuser area.
2. The two prevalent devices for removing the paper edge from the photoreceptor are ____________ and ____________.

REVIEW ANSWERS

1. c
2. stripper finger
   puffer

FUSE

The purpose of the fusing step is to permanently adhere or fix the image that was transferred to the paper. After we have transferred the desired image to the paper and removed the paper from the photoreceptor surface; we have toner held on the paper by only the electrostatic field between the positive charge of the paper and the negatively charged toner particles. There is no permanent bond between the toner and paper, its image can be smudged by rubbing it with your finger. What must be accomplished in the fusing step is the permanent bonding (fusing together) of the paper and toner. See Figure 8-1.

MELTING

The permanent bond between the toner and the paper is caused by melting the toner into the paper fibers. In the top left corner of Figure 8-2 below, we see a single toner particle. The carbon black particles are actually suspended within a resin. To cause fusing, we must melt the resin allowing it to flow into the paper fibers and cover the paper with the toner particles. See Figure 8-2.

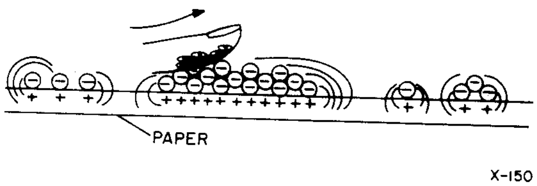
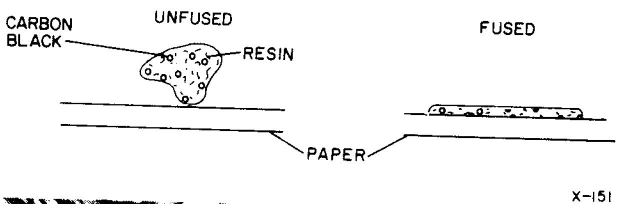


Fig. 8-1.



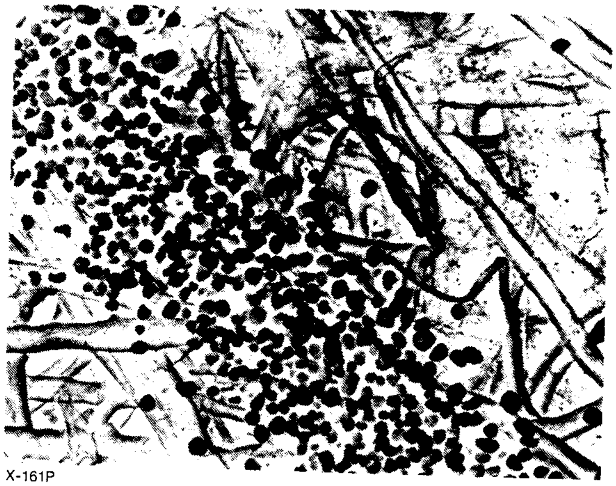


Fig. 8-2.

There is a temperature at which the toner bead changes from its solid state into the liquid state. This temperature is called the "glass index point" of the toner. The glass index point of the toner is not much above room temperature, approximately 120°F. Raising the toner bead temperature to this point can be accomplished in many ways. The important consideration becomes the time required to reach the proper temperature, not the temperature itself.

Let's think about butter for a minute. We have all had butter melt when left outside the refrigerator. If butter is left in sunlight, it will melt because of the radiant energy of the sun. Placing a pad of butter on a piece of cardboard in a heated oven will cause the butter to melt even faster. Placing a pad of butter in a frying pan on the stove while pressing on it will cause the butter to melt even faster. In each of these cases the butter is raised to its glass index point. When the heat source is removed in any of these cases, the butter rapidly reverts to its solid form.

Through this brief discussion of melting butter, we have introduced three methods of melting (or fusing) toner: radiant fusing, "oven" fusing, and conduction fusing under pressure. As the speed requirements of our machines increase, that is, more copies are produced per minute, the speed at which these copies are fused must increase. These three methods listed in order of speed, slowest first, are: oven fusing, radiant fusing and conduction fusing with pressure. A fourth fusing method used in some Xerox processes doesn't use heat at all, but chemically changes the resin to a liquid state, this method is called vapor fusing. Vapor fusing is even slower than radiant fusing, but it has an application in the production of special transparencies (i.e. color). The four prevalent methods of fusing are vapor fusing, radiant fusing, "oven" fusing, and (heat and pressure) roll fusing (chow fusing). Because of the speed requirements of our machines, a combination of radiant and oven fusing, and heat and pressure roll fusing are being used more and more in the most recent machines. Let's look at each of these fusing methods separately.

VAPOR FUSING

Vapor fusing is described as a process which causes the toner particles to become dissolved by the vapors c trichlorethylene. This process is very slow and therefor is only used with those Xerox machines which perform this step in the process manually:

1. The Xerox flatplate
2. Transparency reproduction on the 6500 Color Copiers.

The unfused copy, (see Fig. 8-3), is actually placed o a wire form tray (1) and inserted into a chamber (2) fille with trichlorethylene fumes supplied to the chamber by a wick from the reservoir (3) above it. The vapors of th trichlorethylene dissolve the toner particles and caus them to flow into the fibers of the paper. When the paper is removed from the presence of the vapors the toner reverts to its solid condition fused to the paper. Sinc this is a chemical action it is very slow compared to the high speed requirements of our duplicator products. Also, since it is a vapor fusing process, control of th vapors is a problem. Many people find the fumes offer sive; and, leaving transparencies in the vapor fuser longer than is required can destroy them.

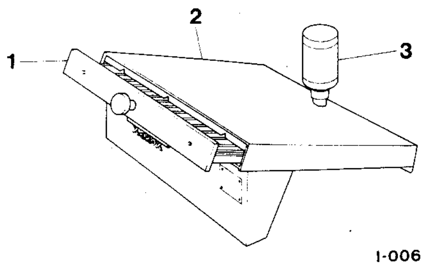


Fig. 8-3.

RADIANT FUSING

Radiant fusing is briefly described as a method of raising the toner to its glass index point using radiant heat. Lamps are used to raise the temperatue of the toner and melt it into the fibers of the paper. (The type of lamp used most frequently today is a quartz rod.) From above, the copy paper is subjected to light from a quartz rod or similar source of intense light. The toner (being dark) absorbs the light and its temperature is raised to its glass index point. When this temperature is attained the toner melts into the fibers of the paper. See Figure 8-4.

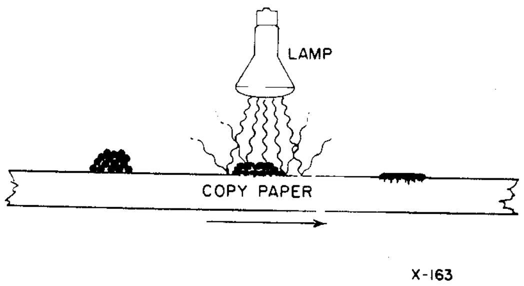


Fig. 8-4.

The toner on the top melts and flows together with the toner near the paper and finally fuses with the paper. The amount of time the paper spends under the lamp is critical in that too much heat absorbtion by the toner can cause the paper to scorch under the toner. Another problem caused by too much heat application is curling of the paper.

OVEN FUSING

Oven fusing is accomplished by convection heating of the toner within a heated chamber like you heat food within an oven. The paper is either placed or transported inside the heated chamber and raised to the glass index point of the toner. The toner then melts and forms a permanent bond with the fibers of the paper. See Figure 8-5.

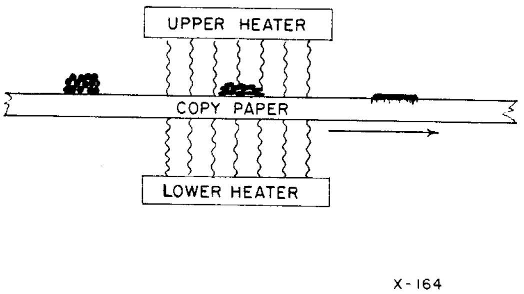


Fig. 8-5.

COMBINATION/RADIANT AND OVEN

In the combination fusing system shown at the right the quartz rod is used to produce radiant energy and supply it to the toner. A heat pad beneath the paper is also used to heat up the paper allowing the fusing operation to be accomplished more efficiently. Since the heat from the lamp is contained within a chamber and the pad beneath the paper also heats the paper you have in effect a combination of radiant and "oven" fusing.

One of the primary concerns in using this fusing system is the amount of time the paper remains within the fusing chamber. If the paper should stop it will almost instantly burn in the area within the fusing chamber. See Figure 8-6.

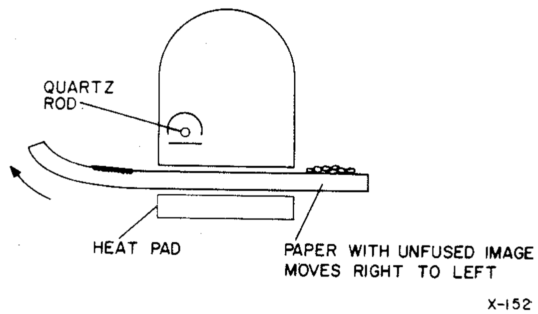


Fig. 8-6.

HEAT AND PRESSURE ROLL FUSING

A fifth method used to fuse the toner to the paper involves a combination of two rolls, one supplying heat and the second adding pressure. The paper with its transferred images passes between these rolls and the combination of heat and pressure permanently bond the toner to the paper. See Figure 8-7.

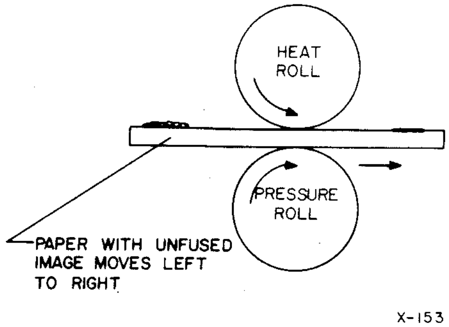


Fig. 8-7.

This fusing method is the one used most often today because it is faster than radiant or vapor fusing. The heat roll usually has a heat source in its center which provides heat from the inside of the roller. The heat source, usually a Quartz rod, is supplied with power and heated. This heat enters the metal sleeve and works its way towards the teflon coating on the outside of the roll. The surface of the teflon roller is heated to approximately 350° F. The heat rolls purpose is to supply enough heat to cause the toner particles to melt. See Figure 8-8.

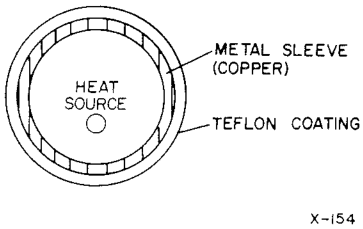


Fig. 8-8.

The paper with its unfused image is added to the system with the image side towards the heat roll. When the heat of the heat roll melts the toner it flows into the paper. But, some of the toner also adheres to the heat roll. To help reduce this problem the heat roll is coated with teflon, and this teflon coating is constantly lubricated with silicon oil.

The third component used in this fusing method is pressure roll. This roller is not heated and is used to push the paper up against the heat roll to help the fusing step. See Figure 8-9.

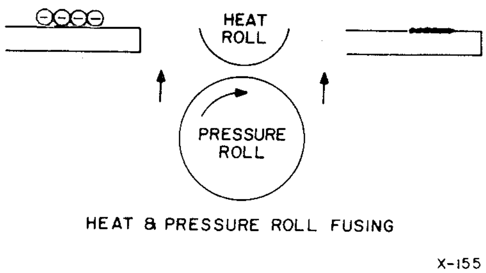


Fig. 8-9.

FUSE - REVIEW

1. What is the purpose of the fusing process?

____

____

2. List the five (5) prevalent methods of fusing used in Xerox equipment today.

   a. ______________________________

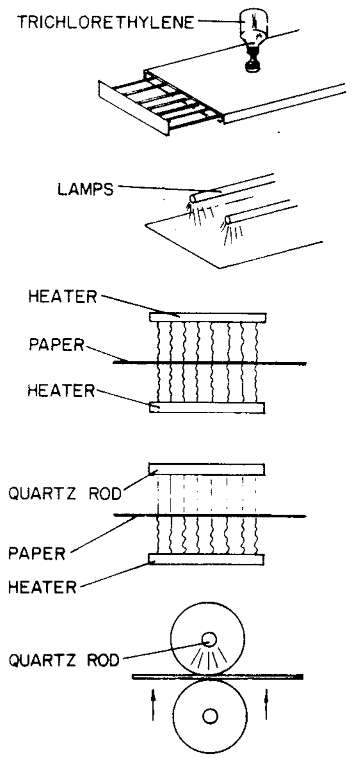
   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

3. Identify each of the fusing methods depicted in the illustration below:



a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

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REVIEW ANSWERS

1. To cause the toner particles to become permanently fixed to the paper.
2. vapor
   radiant
   oven
   combination of radiant and oven
   heat and pressure roll fusing
3. a. vapor
   b. radiant
   c. oven
   d. combination
   e. heat and pressure roll

CLEAN

Cleaning a photoreceptor usually involves these three steps:

- reducing residual image field strength
- mechanically removing residual toner
- removing lingering charge on photoreceptor

Before we can go into the process of cleaning, we have to remember the photoreceptor conditions which exist at this stage in the xerographic process.

The photoreceptor surface in the image area contains a high positive charge and the residual toner particles contain negative charges. This combination obviously leaves a strong attractive field between the toner and photoreceptor image area. Thus all the toner is not transferred to the paper. See Figure 9-1. The machine component used most frequently to reduce that field strength is a corotron. The charge corotron is a DC corotron but the corotron used in the cleaning function is an AC corotron often referred to as a "pre-clean" corotron because it is used before we mechanically remove the toner from the image area.

Fig. 9-1.

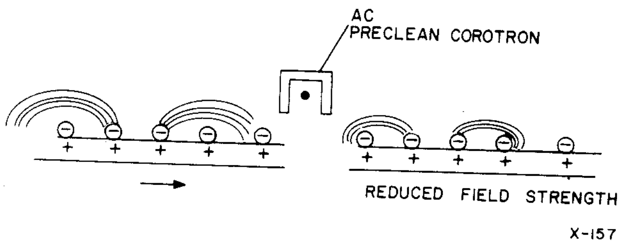


Fig. 9-2.

Step one of the cleaning function has now been accomplished. We have used a positively biased AC corotron to reduce the strength of the field on the photoreceptor.

MECHANICAL REMOVAL OF RESIDUAL TONER

As we have already stated, step two in the cleaning process is the mechanical removal of the residual toner image. After the field strength has been reduced we must mechanically remove the toner from the image areas. This is accomplished in one of three ways: scraping, brushing, rubbing. Each of these three methods are used in Xerox equipment and will be discussed briefly.

Scraping (See Figure 9-3)

The scraping removal of the toner is accomplished by using a rubber doctor blade. This blade is brought into contact with the photoreceptor at an angle so that it will actually scrape the toner from the photoreceptor surface.

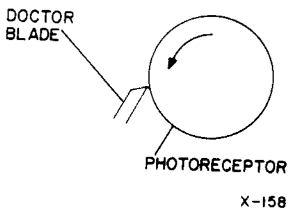


Fig. 9-3.

Brushing (See Figure 9-4)

The brushing removal of the excess toner is accomplished by using a brush and vacuum system after field strength reduction. This is the most prevalent method used in Xerox equipment today.

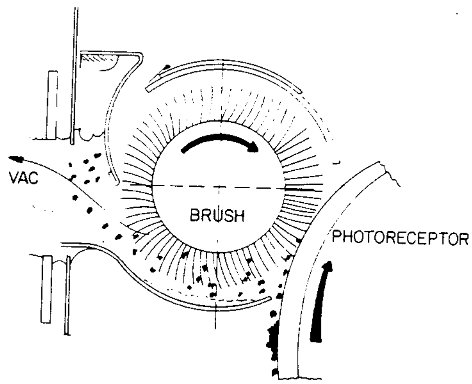


Fig. 9-4. X-172

Rubbing (See Figure 9-5)

The rubbing method of removing residual toner is used the least but is still in use on one family of Xerox machines. This method employs a "web" which actually rubs the toner from the photoreceptor. The "web" is actually a roll of chemically treated (with zinc stearate) paper.

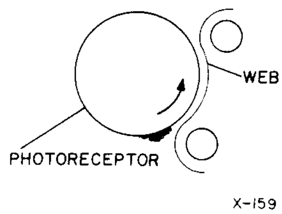


Fig. 9-5.

Each of these three methods are used today in various Xerox machines. Variables considered in their use are: the process speed of the machine, and the developer being used. All three methods accomplish the second step in cleaning, mechanically removing the residual toner from the photoreceptor.

The last step in the cleaning process is removing the lingering positively charged latent image from the photoreceptor surface. Since there is no toner on the image, light would have the effect of exposing the photoreceptor just as it did in the expose step in th process. A light source called a "discharge" lamp i allowed to illuminate the charged photoreceptor surface. This illumination causes photoconductivity just a it did in the exposure step described earlier in thi program. See Figure 9-6.

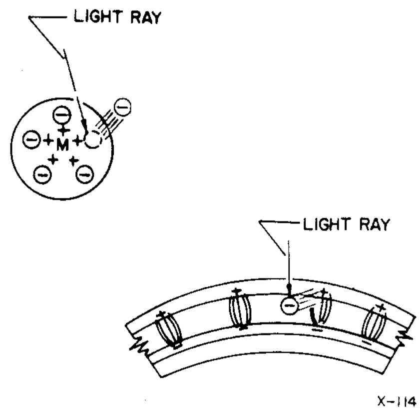


Fig. 9-6.

The results of this exposure is to bring the lingering charge on the photoreceptor surface as close to zero as possible, thus allowing the seven steps of xerography t start all over again.

CLEAN - REVIEW

1. What are the three steps involved in the cleaning function:

   a. ____________________

   b. ____________________

   c. ____________________

2. The corotron involved in the pre-clean step is an AC DC Corotron. Circle the correct response.

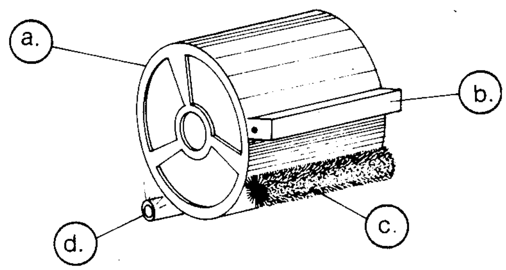
3. In the illustration below, label the various machine components involved in the cleaning function.

   a. ____________________

   b. ____________________

   c. ____________________

   d. ____________________



REVIEW ANSWERS

1. a. reducing field strength
   b. removing toner
   c. discharging photoreceptor

2. AC

3. a. photoreceptor
   b. AC pre-clean corotron
   c. brush
   d. discharge lamp

SUMMARY

To summarize the program I offer you the appendix of the book "My Years With Xerox" by John H. Dessauer. Dr. Dessauer was one of the people mainly responsible for the success of the Xerox Corporation and for the successful evolution of the xerographic process described in this program. He summarized his book "My Years With Xerox" as follows.

A Note On How Xerography Works

Within the context of this book I have purposely refrained from describing xerography in technical terms because such terms might well be unintelligible to many lay readers. For the technically minded, however, the following explanation may be of clarifying interest:

Xerography employs a photoconductive insulating layer on a metal or other conductive support. The layer is charged electrostatically either with positive or negative ions. When the plate is exposed in a camera, those areas of the coating (or photoconductive insulating layer) subjected to light lose a varying portion of the charge, depending on the intensity of the illumination. Thus the variation of the amount of charge retained on the coated metal plate is established as an electrostatic pattern of the image that may be rendered visible by sprinkling electroscopic powders over the exposed plate carrying the opposite charge of the initial charge applied to the photoconductive insulating layer. The powder adheres to those areas that have retained their charge. The print is obtained by covering the plate with paper, then applying a charge over the back of the paper of the same polarity as the initial charge applied to the photoconductive insulating layer. In this way the opposite-charged powders are transferred to the paper surface. The powder is then fused onto the paper by exposure to solvent vapors or heat to make the image permanent.

XEROGRAPHY ... FINAL REVIEW

1. Name the seven steps in xerography in the order in which they happen.

   1. ______________________
   2. ______________________
   3. ______________________
   4. ______________________
   5. ______________________
   6. ______________________
   7. ______________________

2. Increasing the number of electrical charges (increases/decreases) the strength of the electrostatic field, separating the electrical charges (increases/decreases) the strength of the electrostatic field.

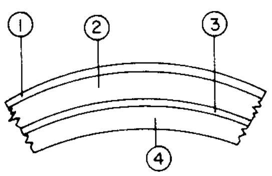
[Complete the sentence by crossing out the wrong word.]

3. A photoreceptor charged positive in the dark, when exposed to light would: ______ (insert letter).

   a. remain positive
   b. become negative
   c. neutralize
   d. oxidize

4. Write the names of the four layers of a photoreceptor in the spaces provided below, use the figure to key your response.

   1. ______________________
   2. ______________________
   3. ______________________
   4. ______________________



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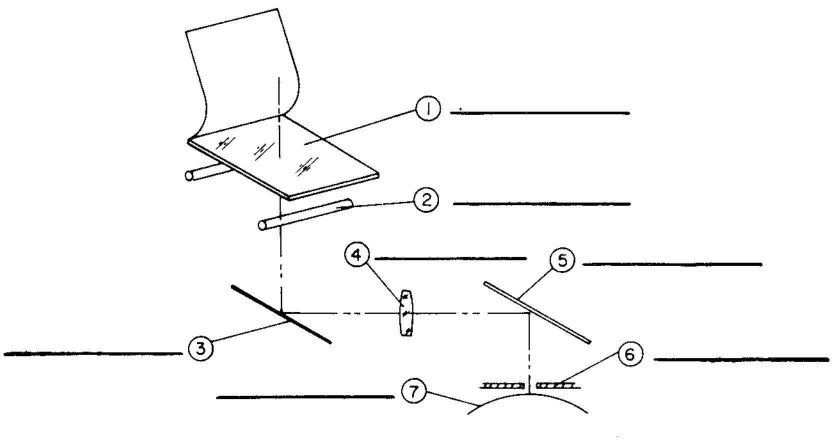
5. The portion of the photoreceptor which actually receives the charge is the ______ (insert letter).

   a. trapping layer
   b. selenium layer
   c. oxide layer
   d. substrate

6. The exposing function takes place at what instance in time ______. (insert letter)

   a. When the exposure lamp is turned on
   b. When the exposure slit opens
   c. When light reaches the photoreceptor
   d. When the mirror assembly moves

7. In the illustration below, label the various machine components involved in the imaging function. (Note: Seven components)



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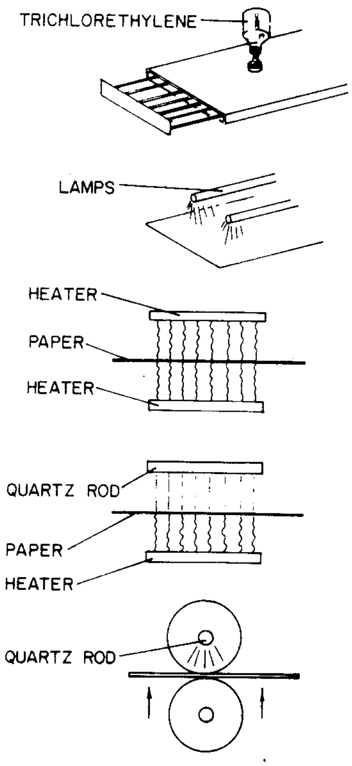
8. List the three prevalent development methods used in Xerox machines today.

   1. ______
   2. ______
   3. ______

9. The purpose of the transfer function is to: ______ (insert letter)

   a. transfer the charge to the paper
   b. transfer the charge to the photoreceptor
   c. transfer the image to the paper
   d. transfer the paper to the fusing area

10. Identify the fusing methods depicted below:
(Insert name in space provided)



X-170

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

11. What are the three steps involved in the cleaning function?

1. ____________________

2. ____________________

3. ____________________