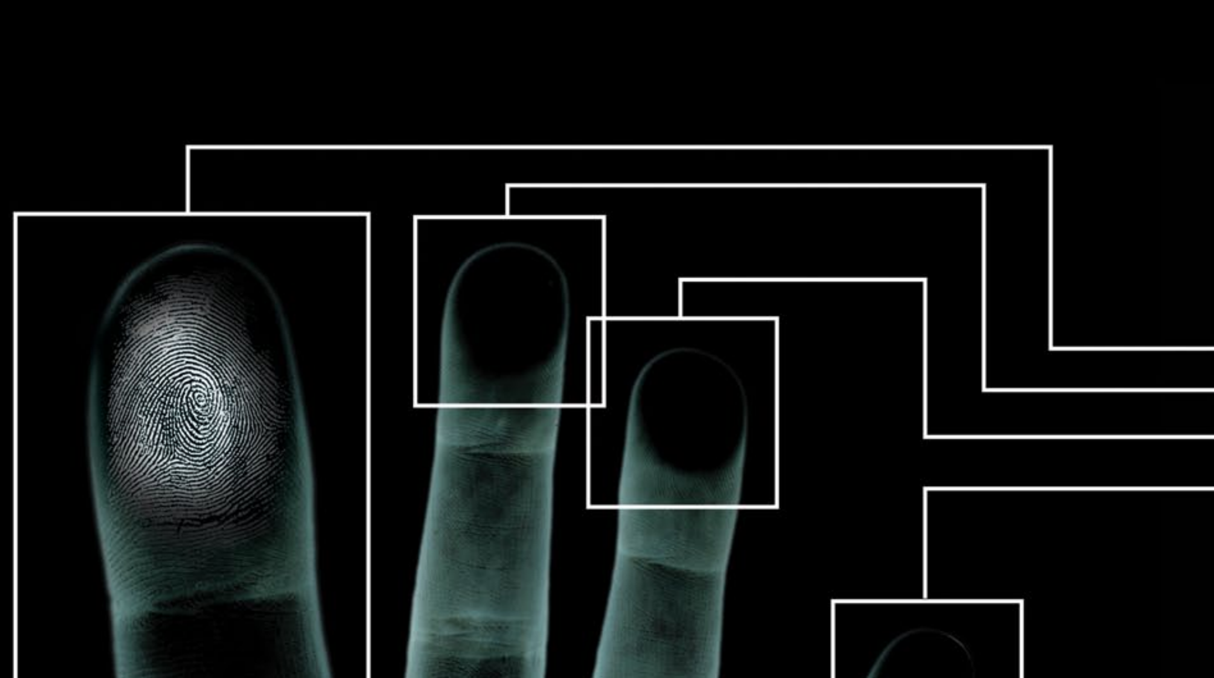
CHAPTER

EQUIPMENT

JULIEANNE PEREZ-AVILA

CONTENTS



CHAPTER 11

EQUIPMENT

Julieanne Perez-Avila

11.1 Introduction

Fingerprints, although they may be found 50 years after being deposited on a piece of paper, are at the same time very fragile and easily destroyed. The arrival of a fingerprint technician at a crime scene marks a critical point in an investigation. It is what he or she decides to do, even unwittingly, that may affect the success or failure of fingerprint evidence collection. A technician must be knowledgeable about the equipment that is available both in the field and in the laboratory. With this knowledge, the technician will be able to select the best method for developing and preserving a print.

This chapter focuses on equipment that can be used easily in the field and equipment that would be found in the laboratory setting. There will, of course, be some overlap between the crime scene and laboratory equipment.

11.2 Crime Scene Equipment

11.2.1 Light Sources

A light source may include any item that produces electromagnetic radiation of any wavelength (from ultraviolet to infrared). Light sources are indispensable to a crime scene responder and a variety of them are useful.

11.2.1.1 Flashlight. A flashlight is an important item that should be in every fingerprint kit. It should be of good quality and produce a strong, even light. A flashlight is typically handheld, lightweight, and powered with batteries. It can be held at an angle to any surface that is being examined.

11.2.1.2 Forensic Light Sources. In the early 1980s, a modified xenon arc lamp* was developed by the Forensic Science Research Unit of Australia, the "Quasar" light source was developed by the Scientific Research Branch of

* The xenon arc lamp was introduced as an alternative to lasers and was commonly referred to as an *alternate light source* or ALS. Later, alternate light sources became known as *forensic light sources*.

the United Kingdom's Home Office, and the "Lumaprint" light was developed by the National Research Council of Canada. Currently, there are many types of forensic light sources (Lee and Gaensslen, 2001, pp 152–153). Many delivery systems using diffraction gratings or filters with various lamps provide a variety of configurations and models. In more recent years, several forensic light sources have been designed to use light-emitting diodes instead of lamps.

The principle for all forensic light sources is basically the same: a high-powered lamp produces a white light consisting of a wide range of wavelengths. An investigator selects certain wavelengths of light through the use of a filter or a diffraction grating. The selected wavelengths pass through an aperture to produce a beam, or the light is directed through the use of an optical device (e.g., fiber optics, liquid light guides). This ability to select various wavelengths can be a benefit not found in most lasers. (For more on lasers, see section 11.3.3.)

The intensity of a forensic light source (FLS) is not as strong as a laser; however, an FLS does have the benefit of being less expensive and more easily transported than a laser (Wilkinson and Watkin, 1994, pp 632–651; Fisher, 1993, p 111).

Forensic light sources are used by shining the light over the evidence or room to help investigators detect latent prints. Contaminants in, and constituents of, a latent print will sometimes cause an inherent luminescence when exposed to certain wavelengths. Certain chemicals and powders can also be used to make latent prints visible. Not all substances become visible at the same wavelength (Fisher, 1993, p 111).

Investigators should wear goggles with filters when using any FLS. The type of goggle needed depends on the type of light used (Masters, 1995, pp 133–142).

11.2.2 Fingerprint Powder Applicators

11.2.2.1 Traditional Fingerprint Powder Applicators. Fingerprint powder applicators come in many shapes, sizes, and fiber components. They may be made from camel hair, squirrel hair, goat hair, horse hair, feathers, synthetic or natural fibers, carbon filaments, or fiberglass. These brushes are used to lightly apply powder to a surface; soft brushes reduce the risk of damaging the fragile print (Fisher, 1993, pp 101–104).

11.2.2.2 Magnetic Fingerprint Powder Applicators. The magnetic brush, or *magna brush,* was developed by Herbert MacDonell in 1961 (MacDonell, 1961, p 7). Since his early design, many variations have been manufactured (Figure 11–1), from large wide-headed applicators to applicators that have a plastic disposable cover for use in situations where potentially hazardous material could contaminate an application (James, Pounds, and Wilshire, 1992, pp 531–542; Lightning Powder Company, 1999, p 3). Most have a similar design: a magnetized steel rod within a nonmagnetic case. The magnetic rod is moveable and can be retracted within the case. When the rod is not retracted, the head of the applicator is magnetized.

To use the magnetic applicator, it is lowered into the magnetic powder. The magnet allows the fingerprint powder to cling to the end of the applicator. The powder that adheres to the applicator will create a bristlelike brush consisting of only powder. This very soft brush is then carefully brushed

FIGURE 11–1

Fingerprint powder applicators.

across the desired surface. The ends of the powder will adhere to the constituents of the latent print and make the print visible. Care should be exercised to touch only the ends of the suspended powder, not the applicator itself, to the surface being processed. This provides a very delicate brush with minimal abrasion to fragile prints.

Excess powder can be removed by first retracting the magnetic rod and releasing the unused powder from the applicator back into the powder jar (or appropriate disposal container, if the powder has become contaminated) and then passing the applicator over the area again to allow any excess powder to re-adhere to the magnet.

11.2.3 Latent Print Backing Cards and Lifting Materials

11.2.3.1 Latent Print Backing Cards. Latent print backing cards are used for recording prints that have been lifted with tape. They typically have a glossy side and a non-glossy side and come in either white or black. The card is usually preprinted with areas for information about the lift (date, case number, location, who made the lift, etc.) and space where a sketch may be recorded.

11.2.3.2 Lifting Tape and Hinge Lifters. Over the years, different types of tapes to lift latent prints have been developed. Aside from the standard clear and frosted tapes, there is a polyethylene tape that has some stretch to it, allowing for lifts to be more easily taken from curved surfaces. Tapes that are thicker than the clear and frosted tapes were developed to conform better to textured surfaces, allowing for more of the print to be lifted. Adhesive tape from a roll may be torn or cut to any length and then affixed to the developed print. Care should be exercised to remove a suitable length of tape in one continuous motion to avoid lines that are created by intermittent stops during the removal of the tape from the roll. (Many examiners prefer not to detach the piece of tape from the roll but instead use the roll as a secure handle for the tape.)

After an item has been processed with powder, the edge of the lifting device (e.g., end of the tape) is pressed onto the surface adjacent to the latent print and the device is carefully smoothed over the print. The tape is then peeled off and placed on a backing card of contrasting color to the powder.

There are also precut hinge lifters of various sizes. These are small pieces of backing material with a same-size piece of adhesive tape attached. They allow an examiner to place the adhesive tape on an impression and then press it directly onto the attached backing to mount it.

11.2.3.3 Rubber/Gel Lifters. Rubber/gel lifters come in precut elastic sheets. They have a low-tack adhesive gelatin layer on the backing material, which is covered with clear acetate. The low-tack adhesive and flexibility of the backing material make these lifters desirable for lifting prints off curved and delicate surfaces such as light bulbs, doorknobs, and paper. The lifters are available in white, black, and with transparent backing material. The transparent lifters can be affixed directly to a lift card, whereas lifters with either a black or white backing material are instead protected with a clear cover sheet and compared as a reversed (mirrored) image.

11.2.4 Casting Materials

When the surface of an item is rough or textured, a casting material can be used to fill the crevices, providing a greater chance of lifting the entire print. Casting material can also be useful to preserve and record fingerprint impressions in semisolid surfaces (e.g., fresh putty used to secure panes of glass in a window) (Bay, 1998, pp 130–132). Casting material is available in a variety of compounds (e.g., silicone, putty, rubber) and colors. A color that will contrast with the print powder should be selected (Morris, 2005).

11.2.5 Cameras

Any type of camera that has accessories for close-up work can be used in fingerprint and palmprint photography (Moenssens, 1971, p 151). However, a camera system with a lens for macrophotography works best. Photographic flood lights or an off-camera flash system for lighting is necessary. These, in combination, form a system that can be used to photograph evidence in the laboratory or in the field. The press or view camera using 4″ x 5″ sheet film was the most commonly used camera until it was replaced by easy-to-use 35 mm cameras. The newer high-resolution digital single-lens reflex cameras are also suitable for fingerprint photography (Dalrymple, Shaw, and Woods, 2002, pp 750–761; Crispino, Touron, and Elkader, 2001, pp 479–495).

11.2.6 Tenprint Cards

Tenprint cards are included as a part of the standard equipment for on-scene print recording. Often, investigators collect latent prints from a scene without obtaining the victim's elimination prints. In most cases, elimination prints can be easily obtained at the scene, but often they are overlooked. If the time is taken to obtain the elimination prints, comparisons can be made and lab personnel are less likely to need to run victim prints through the FBI's Automated Fingerprint Identification System or the Integrated Automated Fingerprint Identification System.

11.2.7 Miscellaneous Equipment

Additional items that should be included in a crime scene evidence kit (Figure 11–2):

1. Retractable tape measure
2. Rulers (metal machine ruler and small plastic rulers; a laser ruler may be helpful as well)
3. Scales to indicate dimensions in photographs (nonadhesive and adhesive for placing on walls, if necessary)
4. Packaging containers (to preserve the evidence in the condition it is found and to prevent contamination)
    a. Paper bags
    b. Boxes of various sizes
    c. Manila envelopes of various sizes
    d. Plastic evidence bags
    e. Evidence tubes (for holding knives, screwdrivers, etc.)
5. Packaging and tamper-resistant evidence tape (for sealing the packaging containers)
6. Warning labels (for biohazard and chemically processed evidence)
7. Dust masks (for use with powders, especially in an enclosed area) and respirators (for use with chemical reagents that require protection)
8. Clear goggles for use with powder (in addition to goggles with filters for use with FLS)
9. Disposable gloves
10. Handheld magnifier
11. Pens and permanent markers
12. Plastic sleeves for tripod legs (in case of contaminated scenes)

Sometimes evidence needs to be collected for processing at the laboratory. Tools to help the technician collect evidence include:

1. Screwdrivers
2. Socket wrenches
3. Reciprocating saw
4. Pry bar

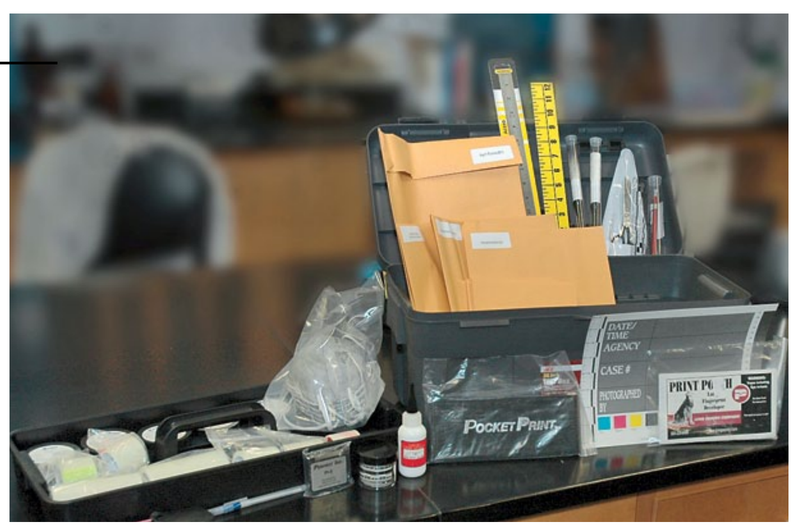


FIGURE 11–2

Evidence kit (with rulers, manila envelopes, and other items).

As a technician gains experience and finds what works and what does not, he or she can modify his or her personal kit as needed.

11.3 Laboratory Equipment

11.3.1 Cyanoacrylate Fuming Chambers

Cyanoacrylate ester (CA or CAE) fuming, commonly referred to as *superglue fuming,* was introduced into the United States in the early 1980s as a way to develop latent fingerprints (Norkus, 1982, p 6; Kendall, 1982, pp 3–5). The prints are developed when CA vapor molecules react with components in the latent print residue. As these molecules collect, they begin to form clusters, often becoming visible to the naked eye. These clusters may then be photographed or processed with powder or chemicals.

Cyanoacrylate fuming chambers have two basic equipment requirements in addition to glue. First, the fumes must be contained. Anything from a commercially made chamber (Figure 11–3) to a simple plastic bag, garbage can, or fish tank (Figure 11–4) can be used. The second requirement is proper ventilation. Both of these requirements are used to contain the fumes and limit the operator's exposure to them, since they may be irritating to eyes and mucous membranes.

FIGURE 11–3

Fuming cabinet.

FIGURE 11–4

Fish tank in fume hood.

The development process may be accelerated by adding a heat source, such as a coffee cup warmer. This heat causes the glue to vaporize, thereby developing the latent print more rapidly (Lee and Gaensslen, 2001, p 119). Small containers, known as *boats,* are used to contain the liquid CA for placement on the heat source. The chamber should also include a system to separate and suspend the specimens that are being processed.

The vacuum fuming chamber (Figure 11–5) was developed by the Identification Division of the Royal Canadian Mounted Police, and a description of its usage and results was published in the early 1990s (Lee and Gaensslen, 2001, pp 119–120). This chamber vaporizes fumes from cyanoacrylate under vacuum conditions without the white buildup of residue that might typically occur when fuming in a conventional chamber. In addition, unlike with ordinary containers, there is no need to spread out items to be processed when they are placed in the chamber; everything will still be fumed evenly (McNutt, 2004, p 6). The use of this chamber also makes overfuming less likely, avoiding the possibility of excessive buildup of the residue.

11.3.2 Vacuum Metal Deposition Chamber

A vacuum metal deposition chamber, used for developing latent prints, is typically a steel cylindrical chamber with a door at one end. The chamber is attached to a system of valves and vacuum pumps that work to reduce the pressure to a level where the evaporation of metals may occur. Theys, Turgis, and Lepareux first reported in 1968 that the "selective condensation of metals under vacuum" settles on the sebum (fat) films, revealing latent prints. This procedure sequentially evaporates small amounts of gold or zinc in a vacuum chamber, and a very thin metal film is deposited onto the latent print, making it visible (Lee and Gaensslen, 2001, p 140). This procedure is effective on smooth, nonporous surfaces (e.g., plastic bags).

11.3.3 Laser

The word *laser* is an acronym for "light amplification by stimulated emission of radiation." According to Fisher (1993, p 111), "Not all lasers are suitable for fingerprint work. The color or wavelength of the output, as well as the light intensity or power output, is important."

The concept for the laser was first noted in 1957 by Gordon Gould, a Columbia University graduate student (Taylor, 2000, pp 10–11). It took him until 1988 to resolve a complex patent dispute and legal battle regarding this remarkable invention (Taylor, 2000, p 284). An article by Dalrymple, Duff, and Menzel (1977, pp 106–115) introduced the use of the laser to fingerprint examiners around the world (Ridgely, 1987, pp 5–12). This article described how natural components in some latent fingerprints luminesce under laser illumination.

There are various types of lasers, but they all basically work the same way. To understand how they work, one must understand the basics of atoms. In simplified terms, atoms

FIGURE 11–5

Vacuum fuming chamber.

Table 11–1

Relative humidity from dry and wet bulb thermometer readings

t – t′ t	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
68	83	78	74	70	66	–	–	–
69	83	78	74	70	66	–	–	–
70	83	79	75	71	67	–	–	–
71	83	80	76	72	68	–	–	–
72	83	80	76	72	68	65	–	–
73	84	80	76	72	69	65	–	–
74	84	80	76	72	69	65	–	–
75	84	80	77	73	69	66	–	–
76	84	81	77	74	70	67	–	–
77	84	81	77	74	70	67	–	–
78	84	81	77	74	70	67	–	–
79	85	81	78	74	71	67	–	–
80	85	82	78	75	71	68	65	–
81	85	82	78	75	71	68	65	–
82	85	82	78	75	72	69	65	–
83	85	82	78	75	72	69	65	–
84	86	82	79	76	72	69	66	–
85	86	82	79	76	72	69	66	–
86	86	83	79	76	73	70	67	–
87	86	83	79	76	73	70	67	–
88	86	83	80	77	73	70	67	65
89	86	83	80	77	73	71	68	65
90	86	83	80	77	74	71	68	65

The left column is the dry bulb reading (t). The top horizontal row is the difference between the dry bulb reading and the wet bulb reading (t – t′). Find the cell at the intersection of the dry bulb reading and the difference of the bulb readings. For example, if the dry reading is 85° and the wet bulb reading is 81°, the difference is 4. Look at the chart and find 85° on the far left and 4 on the top row. Read down and across to meet at 72; that is the relative humidity.

have a nucleus containing protons and neutrons, encircled by an electron cloud. Within the cloud, electrons exist at various energy levels (levels of excitation), depending on the amount of energy to which the atom is exposed by heat, light, or electricity. When the atom gets excited by a specific quantity (*quantum*) of energy, the electrons are excited from their ground state energy level to higher energy states or levels (*orbitals*). When electrons drop back into the ground state energy level, the atom releases energy in the form of a particle of light (*photon*).

A laser contains a mirror at each end that is used to reflect photons. As the photons bounce back and forth between the two mirrors, they stimulate other atoms to release more photons of the same wavelength. This is called *stimulated emission.* One mirror is only partially reflective. This allows a portion of the coherent radiation (a *laser beam*) to be emitted (Menzel, 1980, pp 1–21).

11.3.4 Humidity Chamber

Humidity chambers (also known as *environmental chambers*) (Figure 11–6) regulate the moisture and temperature inside them so optimum conditions for a specific process (e.g., ninhydrin processing) can be achieved. A very basic way to determine humidity is simply to have one wet bulb thermometer and one dry bulb thermometer inside the chamber. The wet bulb thermometer has a piece of muslin tightly wrapped about its bulb. This cloth is dampened with distilled water; as the water evaporates, the thermometer cools. The rate of cooling depends on how much water vapor is in the air. The dry bulb thermometer measures the surrounding air temperature in the chamber. Table 11–1 provides an easy way to determine relative humidity based on the readings of the wet and dry bulb thermometer measurements (Olsen, 1978, pp 197–199). Experience and research have determined that the best prints obtained from treatment with ninhydrin are those that have been exposed to relative humidity of 65–80% (Kent, 1998; Nielson, 1987, p 372). Digital thermo-hygrometers are also available to monitor the processing of humidity and temperature.

In the absence of a humidity chamber, some technicians will use a common household iron to provide a warm and moist environment to accelerate the development of ninhydrin prints. Although this technique is frequently used with success, excessive moisture could damage the prints being developed.

11.3.5 Cameras

As in field work (see section 11.2.5), most cameras and accessories that are capable of close-up photography should be suitable for fingerprint photography in the lab. Special-purpose fingerprint cameras were developed that employed a fixed focus and were placed directly over the print to be photographed. These cameras were equipped with batteries and small bulbs for illumination. They primarily used 2.25″ x 3.25″ or 4″ x 5″ sheet film. Press and view cameras (e.g., 4″ x 5″ Crown and Speed Graphics) were also used and had the advantage of being useful for general crime scene photography.

During the 1960s, the Polaroid Corporation introduced the MP-3 copy camera and, later, the MP-4 (Figure 11–7). The MP-4 became a widely used tool for fingerprint photography within the laboratory setting because it allowed for the use of glass plate holders, sheet film holders, roll film adapters, film pack holders, and ground glass focusing. The use of 4″ x 5″ sheet film to record fingerprints at a life-size scale on the negative is still common in some agencies. However, the trend of using 35mm and digital equipment (cameras and scanners) is becoming more common.

Digital equipment is convenient and produces results that are instantly viewable. Issues of quality are measured in many ways, with resolution and bit depth being two

FIGURE 11–6

Humidity chamber.

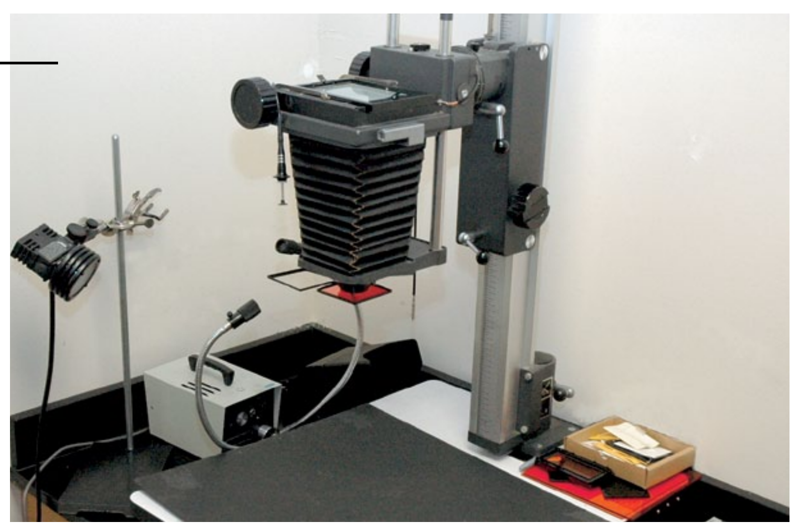


FIGURE 11–7

MP-4 camera.

important issues. "Friction ridge impressions should be captured (color or grayscale) at 1000 ppi or higher resolution. Grayscale digital imaging should be at a minimum of 8 bits. Color digital imaging should be at a minimum of 24 bits" (SWGFAST, 2002, p 277).

11.3.6 Comparison Tools

The customary tools used to perform comparisons include a magnifier, ridge counters, and a comfortable working environment with good lighting. Additional tools that are useful are a light box, a comparator, and an image enhancement system.

11.3.6.1 Magnifiers. A magnifier (Figure 11–8) is a basic piece of equipment for comparing latent prints. A good fingerprint magnifier is a solidly built magnifying glass that has an adjustable eyepiece to allow for individual eyesight variations. Magnification is typically 4.5X with the use of good lighting (Olsen, 1978, pp 171–175).

The magnifier's purpose is to allow the examiner to see sufficient ridge characteristics while still keeping a sufficient field of view. This allows the examiner to evaluate the qualities of ridge details while considering the position of these ridge characteristics relative to one another. Some examiners use two magnifiers (one for each of the prints being compared) and switch their attention (view) back and forth between the prints being compared. Other examiners fold the photograph or latent lift card along the edge of the print in question so that it may be placed adjacent to the exemplar print underneath a single magnifier.

Some magnifiers allow for a *reticle* to be inserted in the base. These discs have a line, or lines, going through them that can be placed over the core and delta of the print to help when doing classifications (Olsen, 1978, pp 171–175).

11.3.6.2 Ridge Counters. A ridge counter (or teasing needle) is a pencil-like instrument with a thick needle attached to one end (Figure 11–8). Other similar instruments with retractable pins are also commercially available.

Ridge counters are used to maintain a point of reference during the examination process. They help an examiner keep track of where he or she is when examining or classifying a print. The proper use of ridge counters requires a light touch to avoid pricking the tape on latent lift cards or damaging exemplars.

11.3.6.3 Light Box. A light box contains a light source and has a semitransparent top made of plastic or glass. It is used for evaluating photographic negatives and transparent lifters (Olsen, 1978, pp 184–185).

11.3.6.4 Comparator. A fingerprint comparator is a desktop projection system that has a light source that magnifies and displays images on a screen. Known and unknown prints (which have been placed on platforms) are displayed side-by-side on a split screen. This allows the examiner to study both prints and is especially helpful during training and when multiple examiners are reviewing and discussing prints. Analog and digital imaging systems were introduced to the fingerprint community during the early 1980s (German, 1983, pp 8–11), and by 1985, numerous laboratories had initiated their use (German, 1985, p 11). Side-by-side fingerprint

FIGURE 11–8

Magnifiers and ridge counters.

examinations are now also accomplished using a standard computer with readily available image-editing software.

11.4 Conclusion

Whether processing a crime scene or processing evidence in a laboratory, it is important to have a good working knowledge of the equipment and what it can do to obtain the best possible results in each case.

11.5 Credits and Reviewers

All photographs by Aaron Matson, Imaging Specialist, Wisconsin State Crime Laboratory, Milwaukee, WI.

The reviewers critiquing this chapter were Robert J. Garrett, Bridget Lewis, Michael Perkins, and Juliet H. Wood.

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11.7 Equipment Suppliers

Armor Forensics
Lightning Powder Company, Inc.
13386 International Parkway
Jacksonville, FL 32218
(800) 852 0300
(904) 485 1836
http://www.redwop.com

Arrowhead Forensic Products
11030 Strang Line Road
Lenexa, KS 66215
(913) 894 8388
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info@arrowheadforensics.com
http://www.crime-scene.com

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Evident Crime Scene Products
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contact@evident.cc
http://www.evidentcrimescene.com

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Raleigh, NC 27624
(919) 556 9670
http://www.faurotforensics.com

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Lenexa, KS 66285
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(800) 255 6499
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http://www.lynnpeavey.com

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