144019

A ONE STEP FLUORESCENT CYANOACRYLATE FINGERPRINT DEVELOPMENT TECHNOLOGY

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A Final Report presented to the National Institute of Justice

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INTRODUCTION

The State of Alaska Scientific Crime Detection Laboratory research team and 3M Company Graphics Research Team have broken the fluorescent cyanoacrylate barrier. For five years, the Alaska Department of Public Safety Scientific Crime Detection Laboratory has researched towards this goal, and the recent NIJ-funded research has been very successful.

Both teams worked independently. The Crime Lab worked towards superior application devices, such as a Vapor Wand, which develops cyanoacrylate fingerprints anywhere in about 20 seconds. This device heats rechargeable cartridges of cured cyanoacrylate and puts forth a stream of vapor which can be used in fume hoods, normal chambers, and outside environments. The device is about the size of a pen; and used in conjunction with a 3M proprietary subliming dye in the cartridges, fluorescent fingerprints are developed with one step.

Also, a crime scene vapor pump has been designed, which is used for large crime scenes such as entire residences.

The following report combines the research conducted by both teams in these areas: <u>chemical synthesis</u> and <u>evaluation</u> of **four** new cyanoacrylate adducts; <u>application devices</u>, using cured cyanoacrylate at high temperatures which are easily exported to field use at crime scenes; and a combination of both teams' research using a subliming dye tag and vapor wand.

A co-volatilization of a subliming 3M thermal material with cyanoacrylate succeeded in tagging fingerprints <u>consistently</u> on all types of surfaces.

This new class of materials actually co-polymerized at the fingerprint site and should lead the way for further investigation. 3M currently has six colors of this material. Two are ultraviolet (UV) and emit exceptionally well with short wave UV excitation.

PART I.A. **VAPOR PUMP FOR CRIME SCENES**

One of the main goals of the project was to make available on a large scale superglue fuming of large crimes scenes. We consider cyanoacrylate fuming of non-porous evidence the contemporary workhorse of the industry, and its use should not be restricted to small laboratory chambers. Entire crime scenes can also reap the benefits of vapor deposition. Since 1987, the Alaska Department of Public Safety Scientific Crime Detection Laboratory has processed numerous entire crime scenes via various techniques with dramatic success.

The need to process via vapor deposition in a timely manner, i.e., an entire crime scene in 1 or 2 hours, was the motivating factor behind the development of the vapor pump.

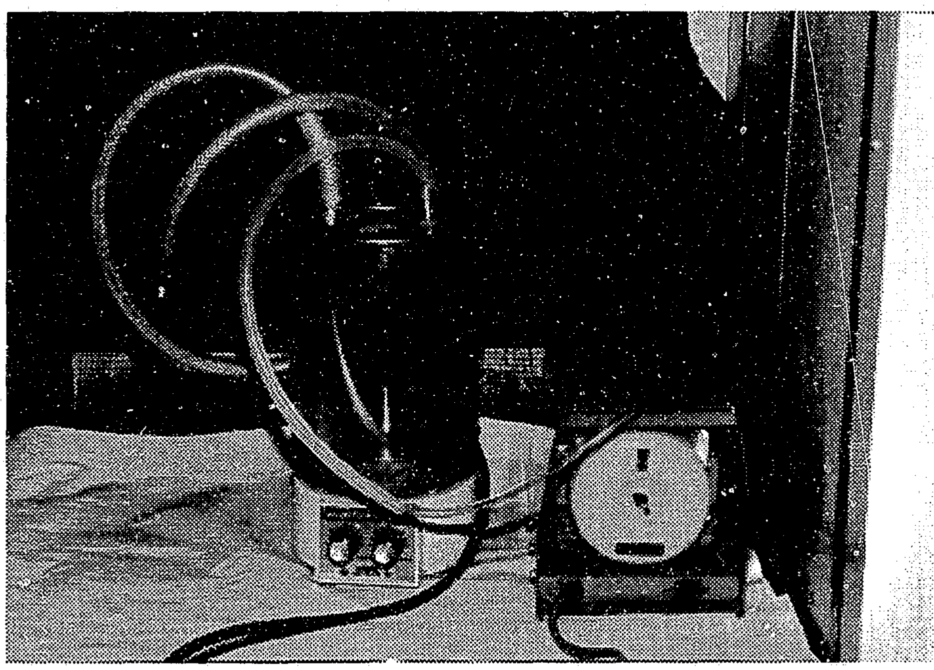


Diagram 1: Vapor pump with compressor vapor chamber and heat source.

The vapor pump consists of a small compressor, heat source, and vapor chamber (1 gal. size). The chamber has a small port cut in the top covered with tape, and liquid cyanoacrylate is periodically added via the port. The compressor pumps air into the heated chamber, and vaporized cyanoacrylate is ejected through the exit hose. This hose is inserted into the crime scene from an outside door, window, or hole drilled through a wall.

Recommended Procedures:

An entire household type crime scene can be fumed in 1 or 2 hours. The device is controlled from outside, and fingerprint development can be monitored via known exemplars deposited on foil strips near windows throughout the residence. Circulating the vapor inside the crime scene is done with auxiliary fans inside the residence. Appropriate air evacuation is completed before entering the crime scene. This can be accomplished via the standard large fans that are readily available from most fire departments.

Crime scene fuming has aided in the visualization of latent ridge detail while securing the impressions from further degradation from subsequent packaging and transport to the laboratory. We feel this process gives maximum efficiency in the development and preservation of crime scene latent print evidence.

PART I.B. **VAPOR PUMP FOR FUME HOOD**

A small vapor pump was also designed for use in the laboratory fume hood. This device employs heat acceleration with the added ability of directional control of vapor deposition. Fingerprints are developed in as little time as 30 seconds, and the fingerprint development can be monitored/controlled and visually observed as the fingerprints become visible. The cyanoacrylate vapor is applied via a small disposable flexible tube directly to the evidence surface. Compressed air is used to provide the airflow; very little positive pressure is needed. It has been our experience that the slower the airflow, the quicker the polymer is deposited onto the evidence. The initial prototype was made from a simple Erlenmeyer flask, hot plate, and flexible tubing (see Diagrams 2a and 2b).

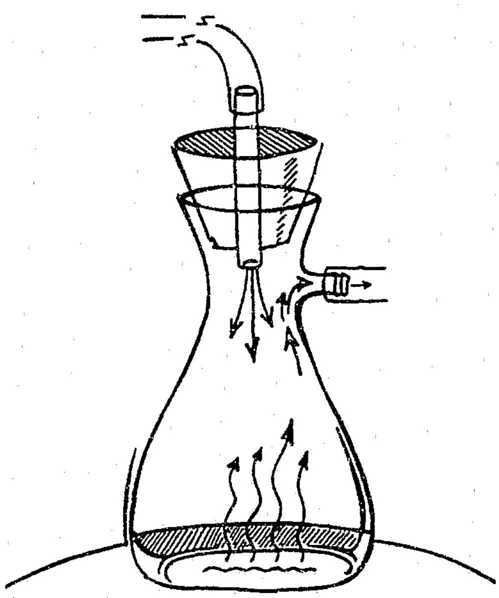


Diagram 2a

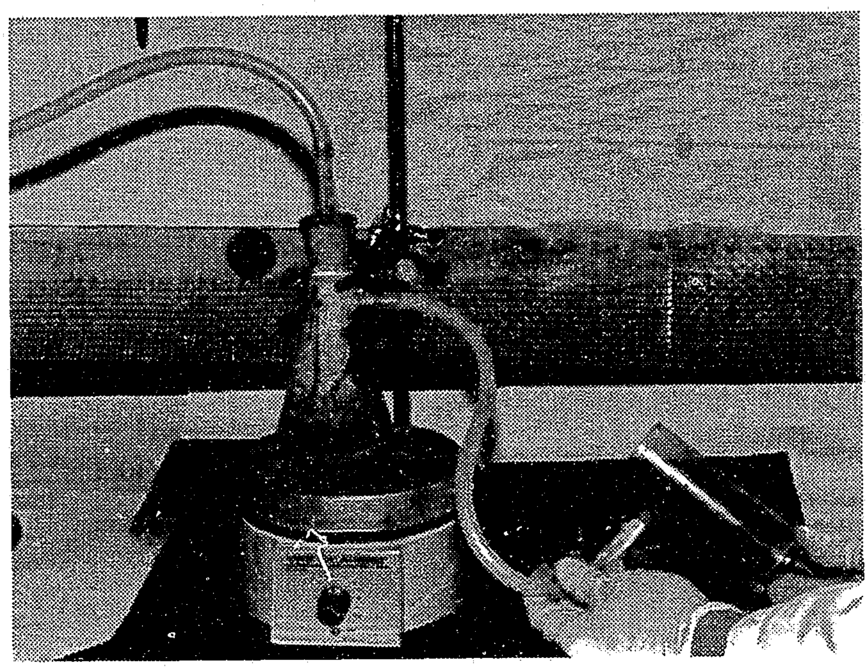


Diagram 2b

This device at first worked very well; however, after extended use, the "distillation" action of the flexible tubing caused a solid polymer buildup and clogged the tube. It was determined that a larger aperture could extend the life of the device and ensure less condensation in the exit tube; thus prototype two was developed (see Diagrams 3a and 3b).

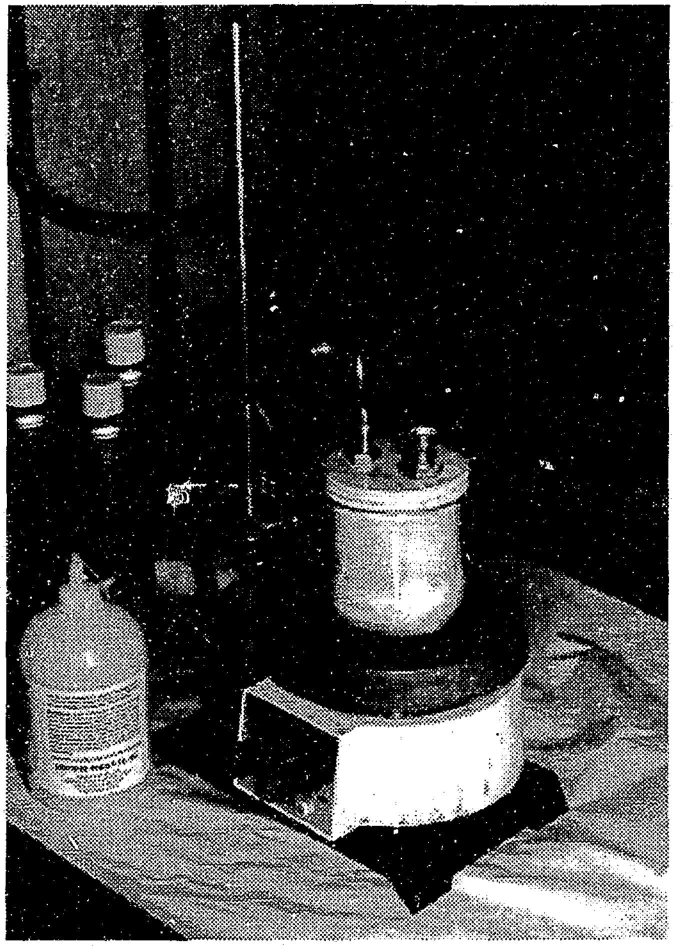


Diagram 3a

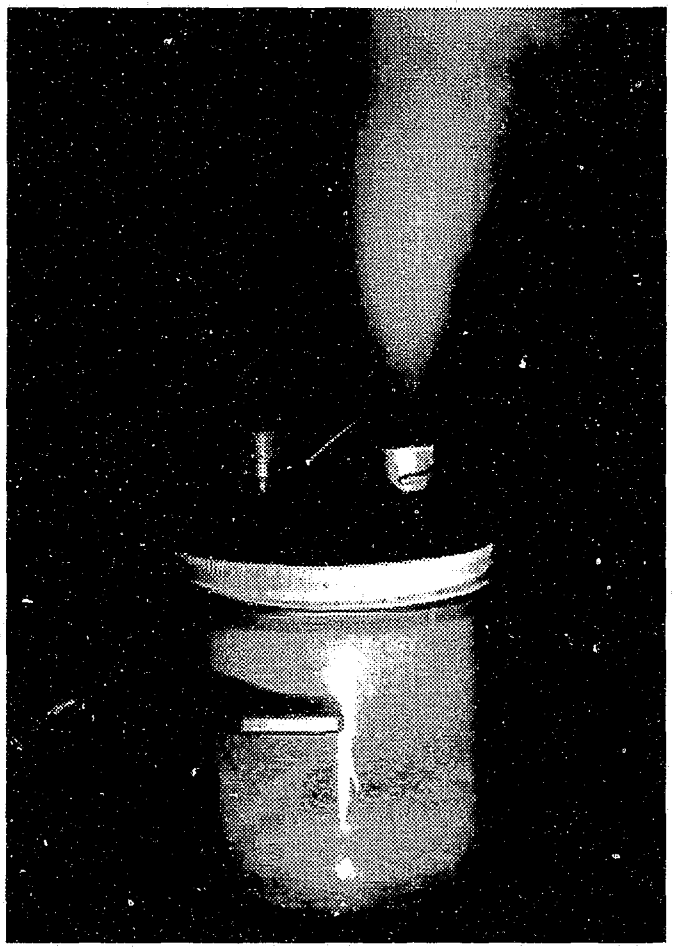


Diagram 3b

In this prototype, all orifices are larger and 1/2 inch tubing is used as the exit tube. While condensation and polymer buildup still occur, the device can be used for several weeks and then the tubing is simply replaced. All mechanical fixtures are coated with petroleum jelly. This inhibits polymer bloom and makes replacing parts easy.

Recommended Procedures:

When you construct your fuming device, it is recommended that 1/2 inch or larger tubing be used with appropriate fittings.

Whenever possible, transparent products should be used so that any polymer buildup is readily observed and removed prior to any obstructions developing.

This device should be used in an appropriate fume hood, and normal safety precautions should be taken.

Adjustable air pressure is best used at the lowest possible setting. If your laboratory fume hood does not have compressed air available, then a standard air pump for a small aquarium can be used.

PART II.A. VAPOR WAND WITH AND WITHOUT THERMAL DYE

Early in 1989, research conducted at the Alaska State Crime Laboratory indicated that elevated temperatures used to vaporize cyanoacrylate and selected dye compounds yielded fluorescent crossover specific to the fingerprint ridges. These early attempts were the precursor to the development of the vapor wand. These initial experiments gave hope for a successful route for a co-polymerization scenario in which a fluorescent dye would be incorporated in the polymer matrix.

While the fluorescent cyanoacrylate was being developed by 3M, various methods for delivering controlled quantities of cyanoacrylate monomer vapor were being tested at the State of Alaska Crime Laboratory. What was needed was a portable device that would produce generous quantities of vapor without electricity since many crime scenes are located where no 110 volt AC power is available. Different means of vaporizing cyanoacrylate have been used in the past. However, the most efficacious still appears to result from heating the polymer. A small, portable, non-electric, high-heat source was required.

<u>VAPOR WAND</u> - A simple, portable "heat wand" capable of delivering significant quantities of cyanoacrylate monomer vapor mixed with a magenta dye was developed to produce a one-step cyanoacrylate dye visualization process for the development of latent fingerprints. Additional dye materials have recently been tested with success in the UV arena. There is <u>true specificity</u> of the dye for the polymerizing cyanoacrylate and thus for the <u>latent fingerprint</u>. The dye belongs to a class of compounds that can be "tuned" to have various optical properties.

A solution was found in a small (slightly larger than a fountain pen), portable, butane-fired soldering iron (master appliance UT-50). This device can be fitted with a new or spent .223 brass cartridge casing, which has had its base removed, thus making a brass flame spreader/holder for the cyanoacrylate. The brass is lined with steel wool onto which methyl cyanoacrylate can be added drop-wise. Several of these brass holders may be made in advance. The soldering iron, matches, and half a dozen "cartridges" fit easily in a shirt pocket. When the soldering iron is lighted, a small catalyst continues to produce flameless heat in good quantity. The cyanoacrylate holder is slipped over the end of the soldering iron, and generous quantities of cyanoacrylate monomer can be directed from the end of the "wand" towards any possible evidence. This tool is a delight to use in a fume hood or it can easily fill a large glass fuming tank in a minute. The device has been used successfully at outside crime scenes and brings the cyanoacrylate vapor deposition out to the field, i.e., burglary of vehicles, points of entry, etc. This is a significant improvement for fingerprint development in outside environments. Caution should be used as the vapors are quite noxious.

Recommended Procedures:

WARNING! Accelerating cyanoacrylate at high temperatures can create vinyl cyanide in low percentages. Quantitative thermographic analysis shows up to 3% vinyl cyanide can be generated with this procedure. Most Latent Fingerprint Examiners are used to working with hazardous materials, and all normal safety precautions should be taken. Accordingly, appropriate fume hoods or proper ventilation must be ensured.

The normal Material Safety Data Sheets (MSDS) for cyanoacrylate will not apply as we are using these materials outside their normal usage.

3M is starting the toxicology reports for these dye materials. No MSDS are currently available.

This entire system is still considered experimental, and appropriate precautions need to be taken.

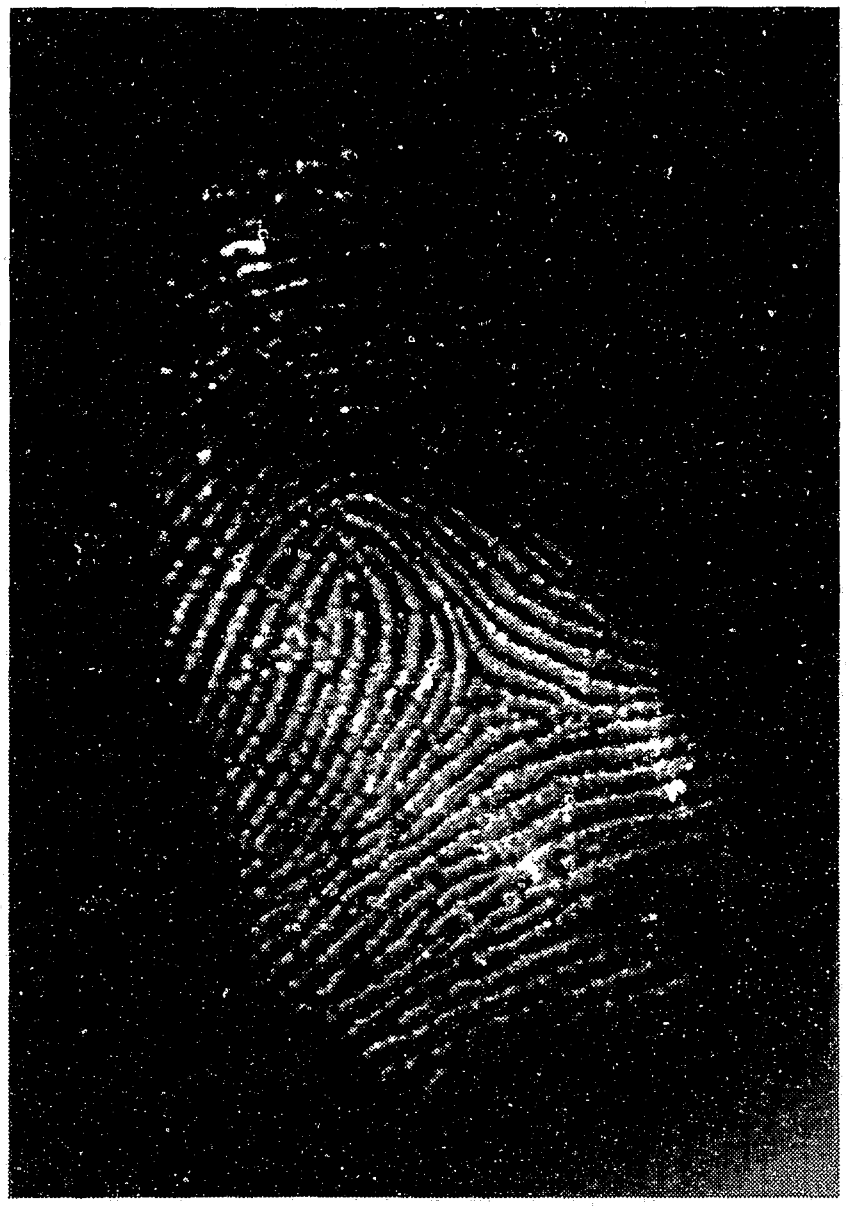


Diagram 4: Photo of latent print dye stained with a 3M proprietary dye of the Styryl dye family.

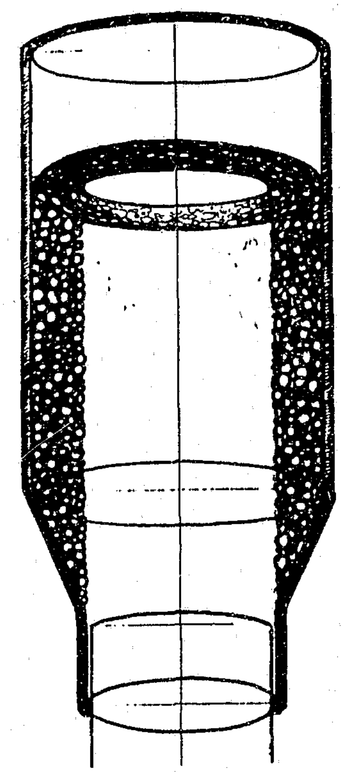
PART II.B. THERMAL DYE AND SUBLIMATION CARTRIDGE

We have found this 3M proprietary dye of the Styryl dye family to have excellent sublimability at relatively low temperatures. When this material is mixed with cyanoacrylate monomer and this mixture is then heated, it sublimes with the cyanoacrylate monomer fumes and is incorporated in the polymeric resist developed at the site of the latent fingerprint. Upon irradiation with an Argon laser, this developed resist fluoresces in the red orange (approximately 600 nanometers) area of the spectrum. Other materials have recently been tested with great success in the shortwave UV arena.

Further information concerning this new dye material can be obtained by contacting: John F. Eisele
201-35-01
3M Center
St. Paul, MN 55043
(612) 733-5747

Diagram 5: Enlarged interior view of sublimation cartridge.

This prototype is made from standard 22-250 caliber brass cartridge, which has had the primer base removed. The cartridge is cut with standard hand-operated pipe cutter.
NOTE: It is important to keep the cartridge length less than 3/4 inch. This size will send out vapor for 3 to 5 minutes. Fingerprints often are developed within 30 to 40 seconds. The steel wool cartridge is rechargeable. Just add a couple of drops of liquid cyanoacrylate.



Diagrams 6a, 6b, and 6c (following page) show a flat base with a vertical post attached, which is used to shape the steel wool lining. The modified cartridge is slid down the vertical post, and the steel wool is stuffed down around the sides and compressed. This vertical post provides the tunnel for exhaust to escape from the torch.

Diagram 6a

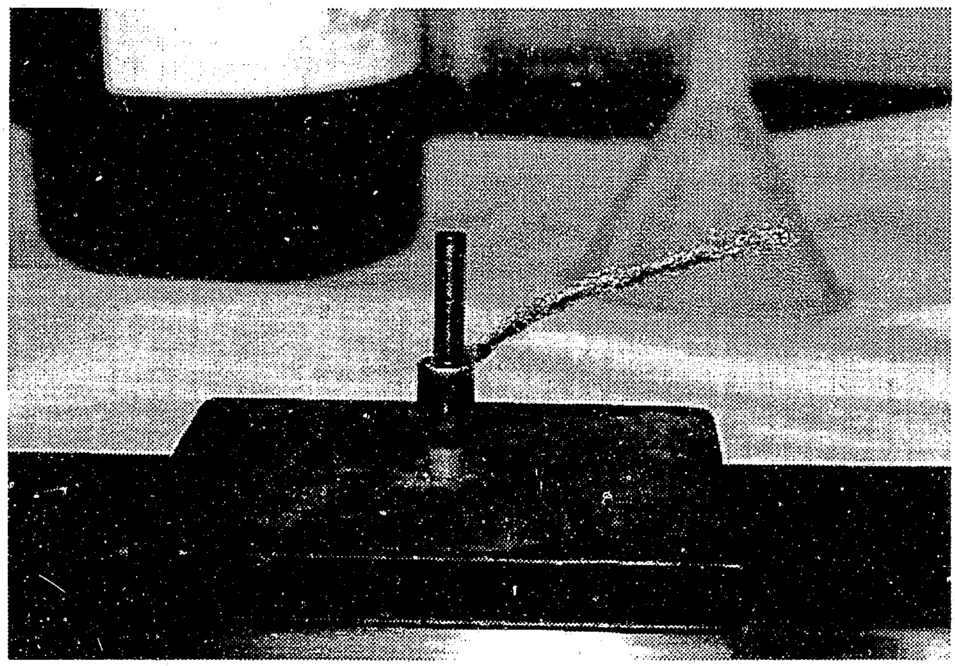


Diagram 6b

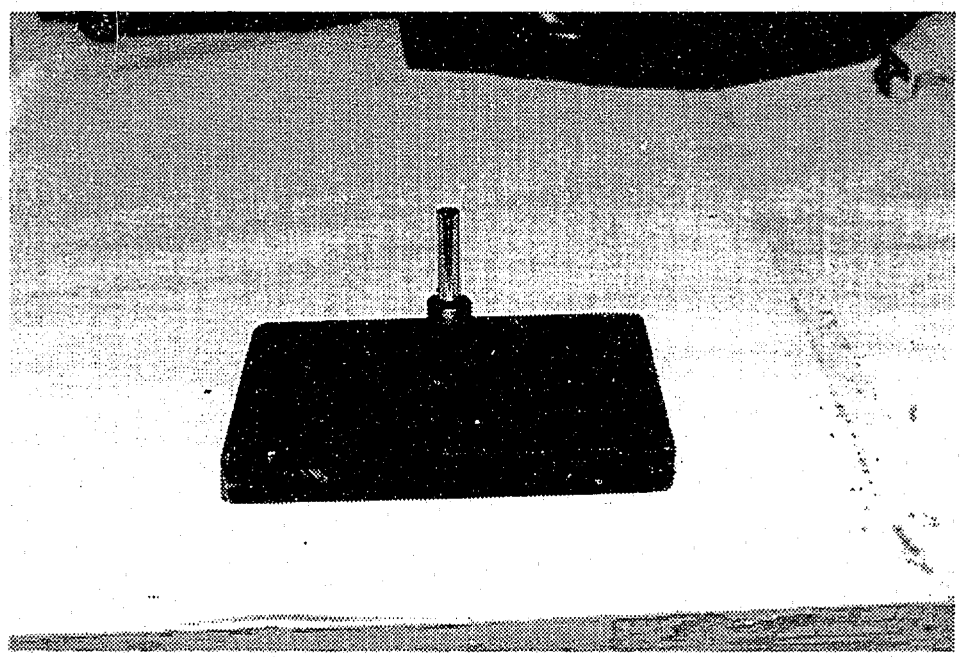


Diagram 6c

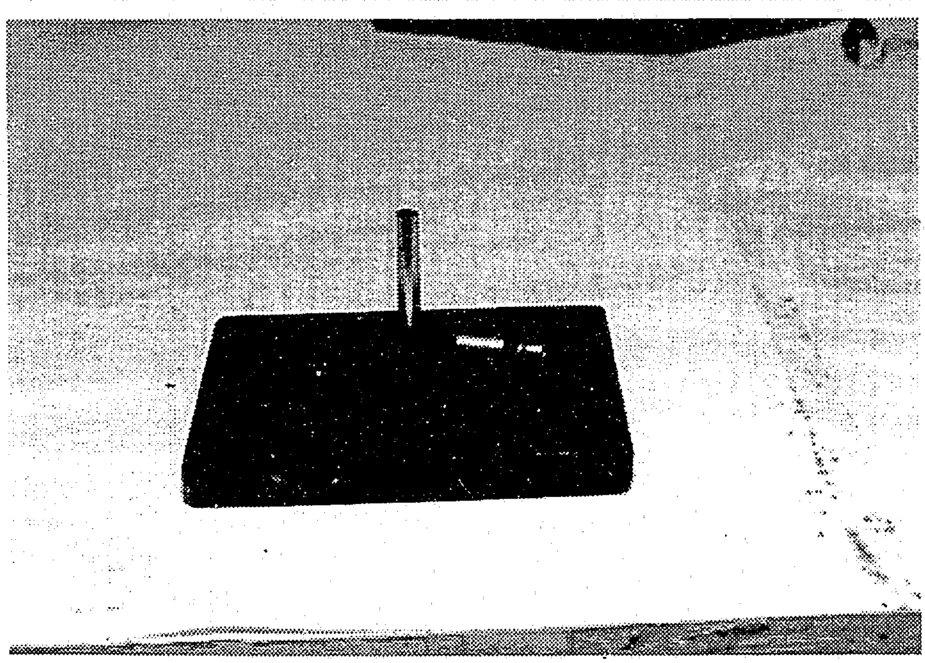
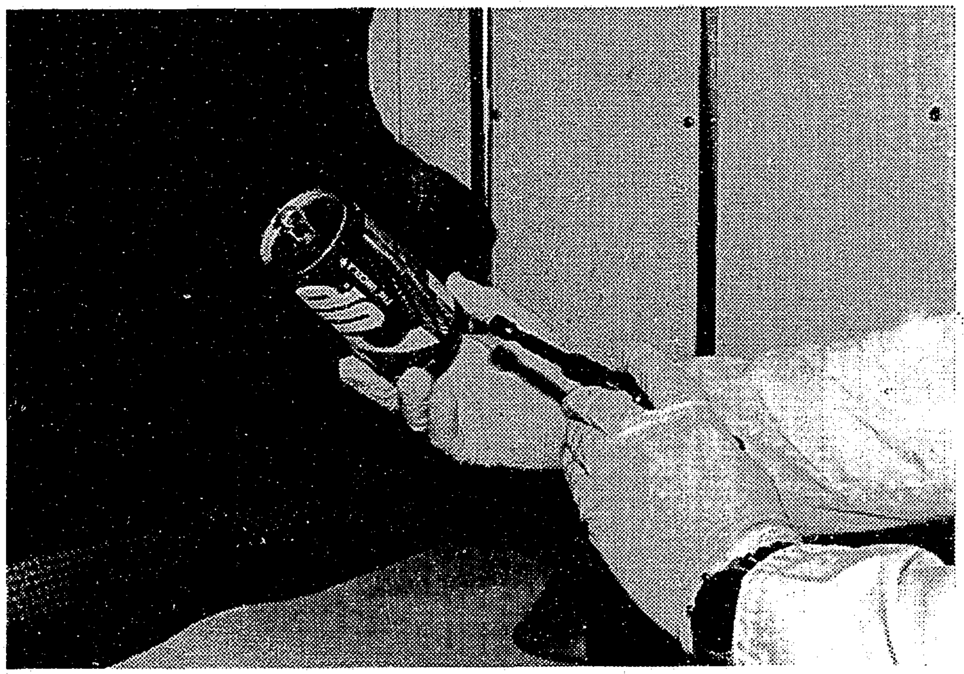


Diagram 7a



The device IN use. After the torch has been ignited, the cartridge is simply slid onto the torch end. In less than 1 minute, you have a stream of cyanoacrylate vapor that can be injected into any chamber or directed at evidence for immediate fingerprint development.

Diagram 7b

Dr. Henry C. Lee, Chief of the Connecticut State Police Forensic Laboratory, using the vapor wand on a vehicle.

PART III. RECOMMENDATION FOR FUTURE

The most significant achievement of this research endeavor is the discovery of the co-polymerization reaction of the 3M subliming thermal Styryl dye family and the development of the vapor wand.

The combination of this device and the class of thermal subliming dye materials should surely open the door and stimulate further research.

Additional work should be done with this Styryl dye family. This material sublimates readily and develops with cyanoacrylate to form a resist specific to fingerprint residue. This phenomenon occurs primarily in the vapor stream; however, with higher concentrations of dye material, coverage occurs throughout the chamber.

3M is currently refining the materials. We hope to announce production and general availability in the 3rd Quarter FY '93.