

Static Electricity: An Introduction to the Problems and Their Solutions in the Film and Television Industries

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This article discusses the how and why of static electricity, and some of the problems it causes for the film and television industries. The roles of static eliminators, ionized air blowers, and anti-static solutions are discussed, among other solutions. The aim of the article is to increase understanding of the basic nature of static, with particular reference to its effect on dust contamination, and to provide simple solutions leading to improved quality, reduced waste, improvements in operator satisfaction, and generally increased profitability.

BEFORE analyzing the problems of static which affect the film and television industries, we will briefly review the way electrostatic charges occur.

The Nature of Static

All matter consists of atoms. Each atom has a positive nucleus around which flow negative electrons. If an atom is *not* disturbed, the positive nucleus and the negative electrons will remain equal and in balance. We will refer to these as positive and negative ions.

If we separate two pieces of material, whether or not they are similar or dissimilar, a transfer of ions will take place, thus leaving one piece of material positively charged and the other negatively charged. If one material is non-conductive (such as film) and the other is conductive (such as metal), the charge will remain on the non-conductive item but will dissipate in milliseconds across the surface of the conductive material.

If two nonconductive materials are separated, they will both retain a charge, one being negatively charged

and the other positively charged. These charges can remain on the surface of the non-conductive material for hours, and very often, days. It is also possible to have a non-conductive material with more than one charge located within millimeters of another — each of a different magnitude and/or polarity.

Some interesting natural phenomena may help to illustrate the character of static. They range from balloons sticking to walls to the more serious problem of potential cardiac arrest faced by British soldiers during the Falklands invasion. Due to very low humidity in the South Atlantic area, the friction of the helicopter blades through the air charged it and its occupants, with the result that the soldiers effectively became human capacitors.

When the soldiers jumped into the sea on a rescue mission, the charge immediately dissipated. The danger arose because the charge was so high that had the discharge coincided with a critical stage of the heartbeat, there was a real danger of cardiac arrest.

General Conditions

Now we will briefly examine the general conditions in which we find static arising.

Friction

When two surfaces are rubbing together, one acquires and retains an

excess of electrons becoming negatively charged, leaving the other with a deficiency of electrons, and thus positively charged. If both surfaces conduct electricity, the balance is restored immediately and the friction ceases.

If one surface is a conductor and grounded, it will restore its deficiency, to or from earth, and remain uncharged. If not grounded, the charge will distribute over the conducting surface, reducing the charge to an insignificant level. However, the charge cannot distribute itself over *non-conducting* surfaces, e.g., film, most man-made materials, plastics, papers, etc., but remains concentrated where it is generated. The resulting potential can be large, depending upon the surface's properties, speed of friction, and ambient humidity.

Another method of creating a charge is by forcefully *separating* surfaces which have been in close contact. Electrons are transferred on the surfaces creating charges; i.e., the deficiency or excess of electrons causing the surfaces to be positively or negatively charged respectively. The type of material separated, the area in mutual contact, speed of separation, and the atmosphere's ambient humidity influence the size of the charge.

The main environmental factors which affect static are:

Atmospheric Humidity

Non-conducting materials (which localize the charge) are only naturally neutralized through the atmosphere. Thus, relative humidity (RH) is critical, affecting the speed at which the charge dissipates. The higher the RH, the faster the dissipation rate. The atmosphere is less influential upon conducting materials as the charge is spread across the surface, reducing

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the charge's magnitude, and therefore its effects.

Grounding

When conductive material is grounded, the potential is equalized, while with a non-conductor, earthing it may improve the situation. The problem remains, however, because the charge dissipates very slowly.

Speed

The speed of friction or separation affects the magnitude of the charge. Industry demands rapid productivity from machinery which tends to generate high static charges and associated problems, particularly when handling man-made materials.

Repetition

Repeated friction or separation can accumulate high charge levels. As much as 100,000 V is not uncommon.

Reintroduction

It is important to realize that static is only eliminated until the next friction or separation point where it can be reintroduced. Therefore, in installing equipment, one must recognize the critical points if the machine is not to become a Christmas tree for static eliminators.

Static Elimination

We have now briefly discussed the nature of static and the major factors which affect it. Before moving to the specific problems in the film and television industries, a short explanatory note on the principles of static elimination may be in order. There are three basic types: passive, radioactive, and high voltage.

Passive Eliminators

Passive eliminators, such as carbon-fiber brushes, rely on "grounding," and will reduce a charge but not eliminate it in normal use. Although relatively cheap, they do not have much application to the film and television industries.

Radioactive Eliminators

Radioactive-type eliminators, although very effective on installation, are said to degrade due to the half life of the polonium source. It has been estimated by others that the output of Alpha particles (the effective ionization) is some 50% after 4½ months and 17% after 12 months of the unit's original day 1 output. The effect,

therefore, may not be constant. The fact that some unions in the U.K. are generally unhappy with radioactive isotopes in the workplace, together with the need to periodically lease the isotope, may make this type less appealing.

High-Voltage Eliminators

The third type, utilizing high-voltage technology, operates as follows. The electrode or electrodes are housed in an insulated material which is itself encased in a metal conductor. The electrodes are energized by a high-voltage output from a transformer (typically 3500-7000 V). The voltage to the electrodes attempts to break down to the grounded metal conductor, and in its attempt, ionizes the surrounding air, i.e., it breaks the balanced atoms into negative and positive ions. This is known as the Corona Discharge.

Although 7000 V may sound dangerous, it is perfectly safe, as the current is very low (typically 1.75 MA). Today, equipment is available which is totally shockless. This is achieved by capacitive coupling or inducing the power into the electrodes from the high-tension (HT) cable without any direct connection.

Creating ionized air is the simple part. We must now understand how to apply it to solve specific problems. It is necessary to ensure that the statically charged material (such as film) passes within the ionized field. As this happens, a matching process takes place very swiftly. If the film is positively charged, it will have a deficiency

of negatively charged particles. The ionized air created by the eliminator provides an almost limitless supply of "free" positive and negative ions, and therefore the deficiency will be made up by the "free" negative ions in the air being drawn to the surface of the film until the balance is restored and the static charge eliminated.

This is a simple procedure, and it works in reverse! However, often, it is not static that is the problem, but rather the dust contamination which static causes. Therefore, a range of products has been developed to eliminate the static *and* remove the contamination by using soft brushes, compressed air, dust-absorbing compound rollers, or a mixture of these methods.

Dust Contamination

It is important to realize that static on a film will not only attract dust, etc., but will hold it strongly to the surface, thus making normal brushing or wiping alone totally ineffectual. Static elimination is a must.

The manufacture of film (especially black and white) can suffer from static because as it is being manufactured it passes over many rollers, giving rise to many points of separation. Should the static build up to a level where it discharges to earth, like lightning, the whole batch is lost because the light level generated will partially expose the film.

Light-Free Blowers

The careful use of suitably modi-

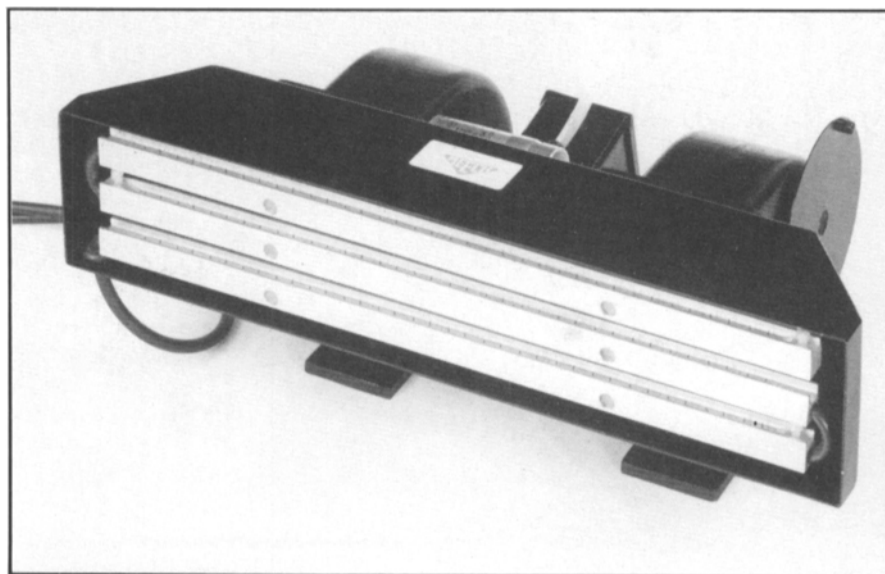


Figure 1. Light-free ionizing blower.

fied light-free blowers containing eliminators can normally solve this problem (Fig. 1).

We will now proceed to the loading room of a processing laboratory. By placing a special light-free ionizer above the winding benches, all the film being wound into the film magazines can be neutralized prior to *loading*, therefore removing the problem of sparking on the film caused by static. The film magazines are then passed to the feed-on stage of the processor.

The elevator cabinet is the area of risk. As the film passes through and over the various rollers, static will build up, and again, the small sparks of static which arise can severely damage the film's quality. Indeed, thousands of feet of film are lost every year.

The solution is to insert the special light-free ionizing air blowers mentioned earlier into the cabinet. By introducing a stream of ionized air into the cabinets, the static is eliminated, and no more film is lost. As the film progresses through the processor, it passes over many separation points, air knives, spools, etc. On its path, static can be reintroduced, especially when it passes into the drying cabinet and then into the take-off elevator. Film strands are often attracted to each other by static, and may be damaged by this scratching.

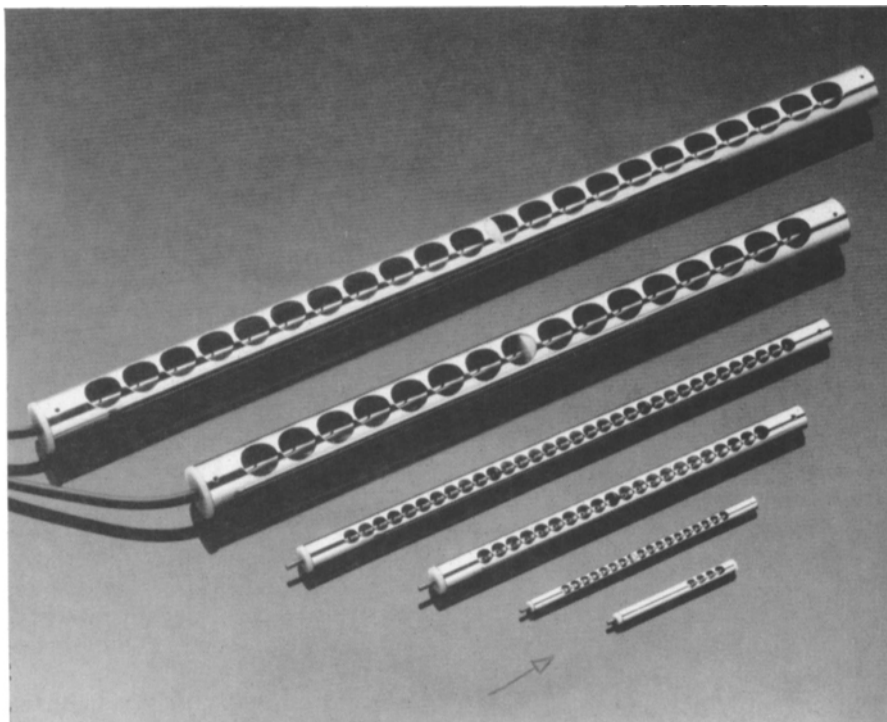


Figure 3. Very small static eliminator.

Shockless Static Eliminators

Again, the remedy is relatively simple. By inserting a shockless static eliminator between the first two and last two strands, static is eliminated on the film and it will not suffer from scratching. In addition, the film will now not attract dust as it emerges from the processor before being

wound up. If a bar in the elevator cabinet is not desirable, one can be placed on the outside of the cabinet at the film exit, although this may only be a partial solution.

There is another alternative to eliminating dust and static outside the processing machine. Static eliminators may be mounted onto the panel before the take-up spool. A design containing two eliminators and a pair of very soft brushes allows the first eliminator to remove the static, and allows the brushes (Fig. 2) to remove the dust. The second eliminator ensures no reintroduction of static — the result being clean and static-free film. This film cleaner is available in a number of variations, i.e., with removable brushes, with a back plate and one spool, with a back plate and two spools, etc.

A similar design is ideal for use on rewind and editing benches, and so forth. Film can travel from either direction being cleaned and neutralized at the same time. Once the film is cleaned, it can be placed on a bench over which an ionizing air blower is mounted, thus keeping this area dust and static-free and ensuring that the film is still neutralized. Ionizing blowers are also often located above printing machines. Again, a stream of ionized air keeps the printer clean and dust-free.

In computerized lab operations,

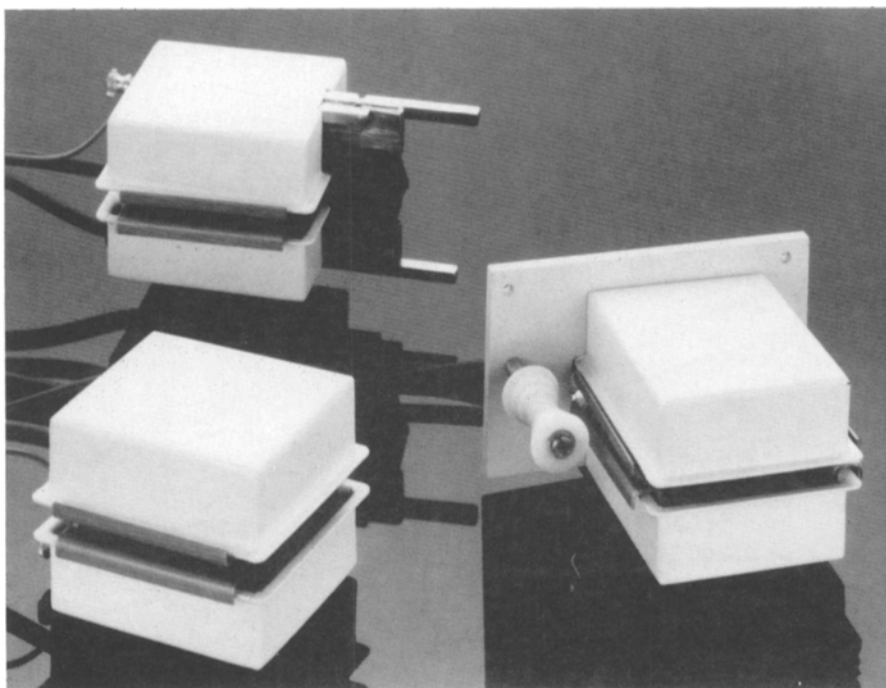


Figure 2. MBBT bar and brush-type film cleaner (not requiring compressed air).

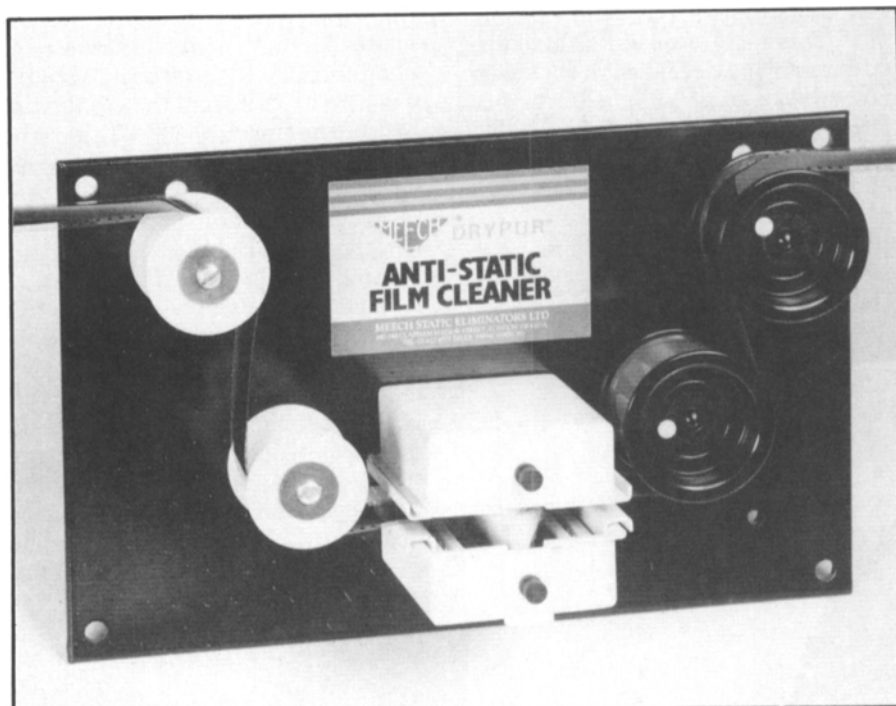


Figure 4. Meech/Drypur film cleaner.

As the larger cinemas tend to use platters (cake stands), more film is exposed to dust and static as it travels from the platter to the projector and back again. Using a static eliminator, soft brushes, and dust-absorbing compound rollers, a combined unit can be installed in the film path (Fig. 4). In one trial with such a combination unit, a print of the successful movie, *The Killing Fields*, was in use for more than three times its normal expected projection life. At the end of 35 weeks of almost continuous projection, it was found to be in pristine condition, and the sound was much better than would have been expected after this period.

Air Guns

Often, dust and static is a problem on lenses, animation stands, cameras, animation tables, and so forth. These are ideal applications for a neutrostat air gun which produces ionized compressed air for application by an operator across the working surface (Fig. 5). The surface will be cleaned and left static-free, thus reducing future dust attraction.

Similarly, the gun can be used on large negatives prior to printing, or to blow off gates on printing machines, projectors, and similar devices. Ionized air can also be applied in various

static is present on visual display units (VDU) possibly on the computer bench, in the operator's chair, and in the surrounding carpeted areas. Its elimination is relatively simple.

Other Solutions

Other kinds of electronic equipment, particularly video devices, are equally susceptible to static discharge. For example, in a telecine suite, someone entering the suite and touching one of the machines, can cause the machine to receive a signal and react disastrously to it. This results because the person who had walked over the carpet had become charged as a human capacitor and discharged to earth as he touched the machine. As much as 20,000 V is not an uncommon static charge after walking across a carpet.

The remedy is simple enough. A professional can apply the correct dilution of an anti-static concentrate fluid to the carpet. This solution works equally well on plastic tiled areas, and will remain effective until the carpet or tiles are professionally cleaned again. Earlier we referred to VDUs, benches, etc. These can also benefit from the use of an anti-static concentrate, or by using an anti-static agent in its aerosol form.

In the viewing theater, static and dust can be a problem. A tiny eliminator (Fig. 3), smaller than a pencil,

made of brass, and having a number of electrodes to suit the material width, can be mounted directly above the film gate in the projector to ensure that the film passing through the gate is completely neutralized. The client then views a clean, blemish-free print.

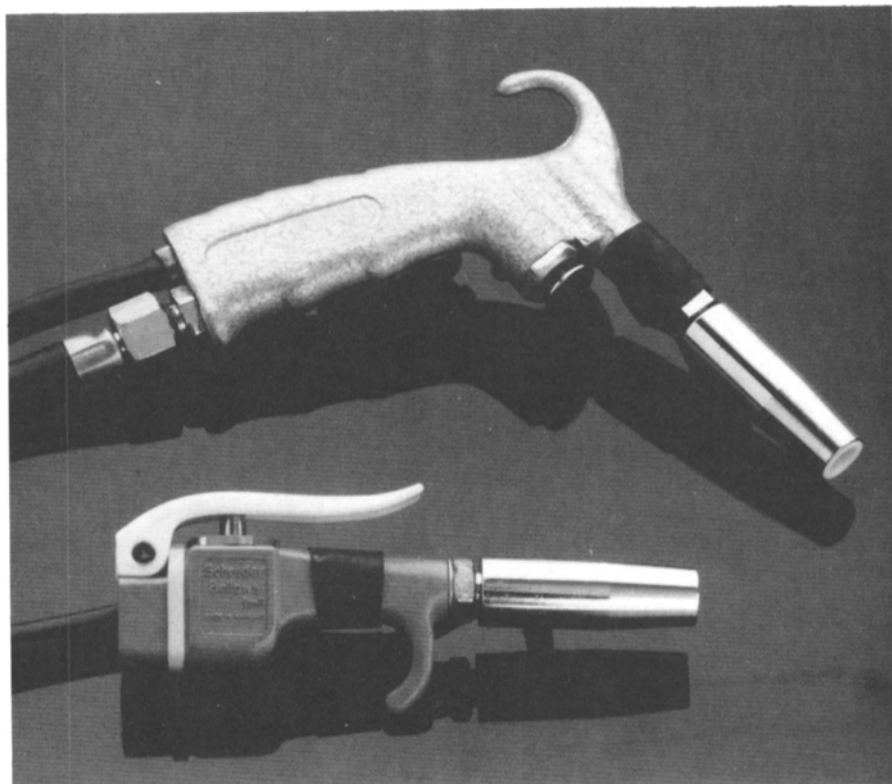


Figure 5. Ionizing air guns for removing contamination.

situations by the use of ionizing nozzles, similar in operation to the neutrostat air gun. However, here they are used in a fixed operational mode; for example, by mounting on a bracket.

A special unit can be fixed above the face plate of a flying spot scanner (Fig. 6). A constant stream of ionized air particles is blown across the face of the CRT, neutralizing the static

charge and effectively removing the dust. This is a safe and efficient method of removing CRT dust. It should be noted that any air supplied, whether from a local compressor or a portable version, must be commercially dry and, of course, oil-free.

Photofinishing Applications

The previous comments have covered only a few applications in the

film and television industries. Motion pictures, film manufacturers, and photofinishing and recording studios can also benefit from the elimination of dust and static. The MAT film strip cleaners using ionizing air nozzles, with the option of a third ionizing nozzle to clean the printing gate, were designed to fit the needs of the photofinishing studios (Fig. 7).

When the operator presses a foot switch, ionized air blows through the two nozzles, the film strip is blown clean, the stay-put nozzle's air stream is directed onto the printing gate, the foot pedal is released, and the negative is placed in the gate and printed. As the gate and the negatives are now dust-free, and higher-quality prints can be achieved consistently without waste.

Conclusion

Understanding static and knowledge of the simple solutions available will, if implemented, lead to improved quality, the elimination of dust contamination, reduced wastage, improvements in operator satisfaction, and generally increased profit. It is difficult to cover every aspect of the problem in a paper. However, I hope I have given you some food for thought.

Acknowledgment

I would like to thank Session Chairman John Baptista for allowing me to present this paper.

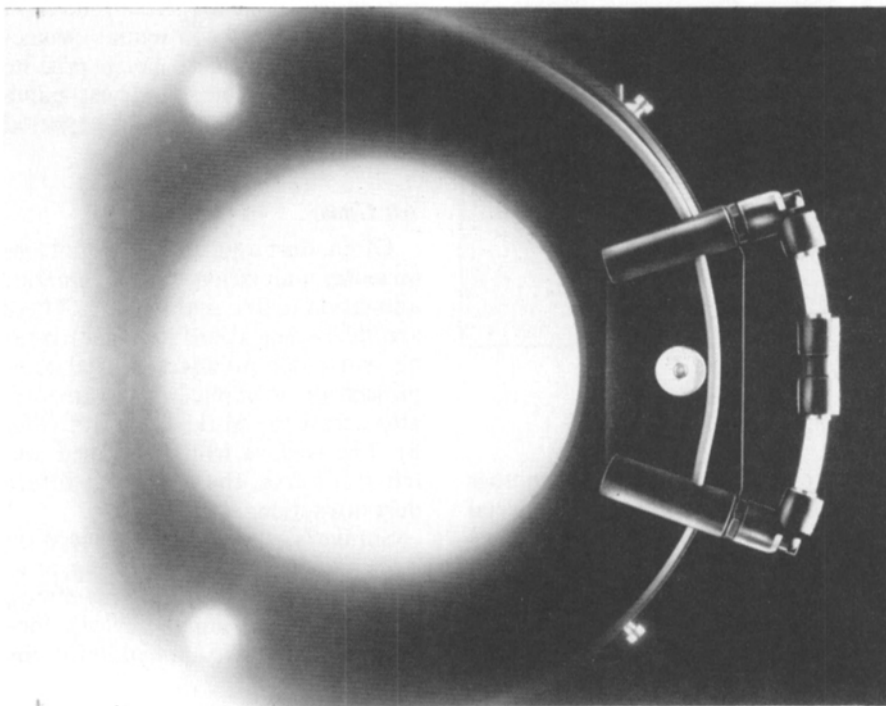


Figure 6. CRT 100 for use on flying spot scanner.

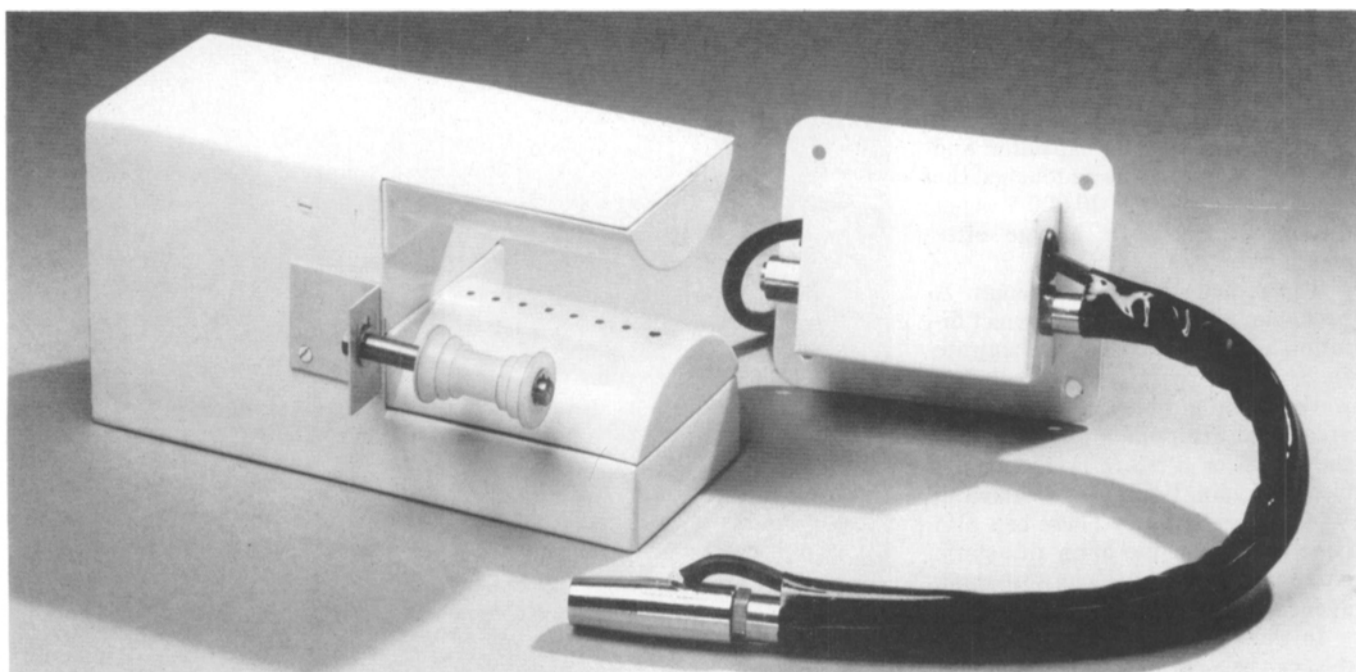


Figure 7. Air-type film cleaners. MAT 1 and photonozzle have particular application for photofinishing.