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FLEXIBILITY OF UNIVERSAL SPRAY COATING SYSTEMS *

by

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Introduction

The world around us is full of products that have undergone surface treatment. Surface treatment is essential in the building trade and in industry to protect products against corrosion and wear, to give them an attractive appearance, to maintain rust protection, to provide insulation and so on.

The choice of surface treatment must be guided by considerations of quality, economy and rational working. Spray painting will always give excellent results on all these items. Hardly any article - pottery, toys, furniture, cars and railway wagons, ships, bridges and iron structures - is too large or too small to be spray coated.

The number of sprayable materials is growing steadily and - apart from paints, now includes cleansing agents, viscose substances and materials in powder form.

In this way new fields of application for spraying are opened and development is constantly going on. The spray coating techniques promises to maintain its leading position also in the future.

Spray coating systems applied today are:
Conventional spray coating;
High-pressure spray coating;
Electrostatic spray coating.

Whichever method is used, spraying may be done manually or automatically, the coating material may be sprayed cold or hot, and a variety of coating material feed systems are available.

This paper describes the various methods, their advantages and disadvantages and the possible combinations.

1. Conventional spray coating

The conventional spray coating method is sometimes also called low-pressure spraying. Compressed air is used both to atomise the coating material and to transfer it to the article to be coated.

Spray coating by the conventional method gives an extremely smooth surface with the best possible finish. Other advantages are quick and easy adjustment of fan width, and quantity of coating material. The purchasing costs for this equipment are low.

This meth l is particularly well- ited for applicat ons where first-class surface is required. It is, therefore, used in the motor-car industry - both during manufacture and for repairs - for surface coating of office machines, refrigerators, furniture, joinery and similar work. It can also be used for spraying prime coats especially where it is important to achieve an even coat.

A conventional spray coating system can be either manually or automatically operated, equipment for hot spray and coating material circulation can easily be added.

Advantages

- First-class finish;
- Uniform coat thickness;
- Easy adjustment of fan width and quantity of coating material;
- Constant operation speed enables the operator to check results;
- Low-purchasing costs.

1.1 How does the system work

The coating material is fed to the nozzle and the material flow is controlled by a needle-valve operated by a trigger. When pressing, the trigger compressed air flows and then coating material is fed through the spray nozzle. The material streams and the compressed air meet outside the air cap and the coating material is atomized. By varying the quantity of air pressing through the horns of the air cap, the fan width and the spray pattern can easily be adjusted. A coarse adjustment for the coating material quantity is achieved by varying the fluid pressure and by using different nozzles. The stroke of the fluid needle is altred for fine adjustment.

1.2 Fluid feeding systems in spray guns

Gravity feed;
Suction feed;
Pressure feed.

1.2.1 Gravity feed

The fluid cup is mounted on top of the spray gun and the material is fed into the gun mainly by its own weight. The compressed air streams through the gun and exerts a certain amount of material by suction. Gravity feed is suitable for spraying at frequent colour changes, for certain special coating materials such as hammer finish and wrinkle enamels,

glazes and varnishes with slightly higher viscosity than normally be used with suction feed.

1.2.2 Suction feed

The fluid cup is mounted below the gun and the fluid is sucked up into the gun by the vacuum generated in front of the fluid and the air nozzles. Suction feed is best suited for spray coating with frequent colour changes and for small quantities of coating material.

1.2.3 Pressure feed

This method may be used in four ways depending upon the capacity required:

- with paint cup below spray gun
- with pressure feed tank
- with low-pressure pump
- with a paint circulation system.

Pressure feed from paint cup mounted below the gun is particularly well suited for spraying small quantities of high-viscose fluid and for laboratory use subject to the same requirements as industrial spray coating. In the pressure feed tank, fluid is forced out of the container by compressed air applied to the material. Pressure tanks are subject to special regulations and must be fitted with an air pressure reducing valve, a safety valve and a manometer. The pressure feed tank is used where fairly large quantities of fluid are consumed. It should hold at least half the daily requirement. Pressure feed can also be done by means of separate low-pressure pumps, or for larger fluid quantities, from a fluid circulation system with a take-off at every spraying station.

There is a wide variety of spray guns on the market. Depending upon the construction, they are more or less light, economically designed, easy to maintain and they generally have an extremely high capacity. Spray guns have excellent results at pressures down to 1 bar (14.5 psi).

The range of products available include manual and automatic spray guns.

1.3 Fluid feeding devices

There are two methods of feeding the fluid to the spray gun.

1.3.1 Pressure feed tanks

Pressure feed tanks range in size from 10 to 300 litres (2.2 to 66 imperial gallons). They are made of strong galvanzied sheet metal and have to comply with current safety regulations. Uniform colour and viscosity are maintained by compressed air driven or manual fluid stirrers.

1.3.2 Feeding pumps

Feeding pumps consist of a piston pump and reducing valve for the fluid. They can be mounted on a lid which fits a standard 20 litre (4.4 imperial gallons) fluid drum. Feeding pumps render possible rapid changes. They are corrosion resistant and can be connected directly to the compressed air system.

2. Air-coating systems

The air-coating system is a combination of conventional and high-pressure spraying. Low-pressure pumps with a ratio up to 28 : 1 are used to deliver fluid to a specially designed spray gun. The fluid is atomized by forcing it through a very tight nozzle. In addition to the hydraulic atomization compressed air is used for a micro atomization of the paint fluid particles.

This method is widely used to atomize very low viscose materials and where a precise metering of fluid is necessary.

Advantages

- Smooth low-pressure application of coating material;
- Possibility of metering the applied fluid;
- No fluid rebounding and reduced foging.

3. High-pressure spray coating

In high-pressure spray coating, the fluid is fed to the gun at an extremely high pressure, as much as 360 bar (5220 psi).

The method is also known as airless spray coating, since the fluid is atomized without compressed air.

Since the fluid is sprayed without air there is practically no fluid fog. The fluid can also be sprayed in thicker coats and can contain

less thinner, so that better coverage and faster drying is achieved compared to conventional spray coating.

High-pressure spraying is advantageous when treating large surfaces with high viscose coating material when coating long runs of products. It can be used on all kinds of material, including steel, concrete, wood and masonery. It is the predominant method in ship and tank coating for exterior and interior surface treatment of buildings, but is also used for coating joinery products, furniture and machines, coach work and so on.

High-pressure spraying can be done manually or automatically and is suitable for hot spraying. It can also be combined with a fluid circulation system by connecting a high-pressure pump to the fluid take-off point.

There are two systems available:

- Electrically operated airless pump
- Pneumatically operated airless pump.

3.1 Electrically operated airless pumps

These types of pumps are motor driven. They are very mobile and can be used on the construction field. Compressed air or a compressor is not necessary.

3.2 Pneumatically operated airless pumps

The pressure is produced by a compressed air driven piston pump. This method is widely used in factories and in-plant operations.

Advantages

- High capacity
- Good atomization, even at high viscosities
- Negligible fluid fog, simpler ventilation
- Excellent coverage, less overspray
- Minimum fluid rebounding

3.3 How does it work

The paint is fed to the nozzle at high pressure. The paint is atomised as it passes through the nozzle, so that rapid evaporation of the solvent combined with air resistance and mechanical resistance breaks it down into very small drops. The print jet, therefore, contains no air.

Fan width and fluid quantity can be altered by changing the tungsten carbide nozzle of the gun.

3.4 Fluid feed systems

Various fluid feed systems can be used in high-pressure spraying. These range from small portable units to stationary installations for a number of spray guns. The simplest arrangement is to mount a high pressure pump directly onto a fluid drum. The system would be used for small, occasional coating jobs. Larger pumps can be mounted on trolleys for ease of transport between jobs. The various types of pumps can be supplemented by fluid stirrers and fluid heaters.

For larger quantities of coating material on fixed coating stations, stationary high pressure systems connected to fluid drums or fluid circulation systems are used.

When using drums, a pump mounted on the wall sucks the coating materials directly from the drum. In a circulation system, the fluid pressure varies, but is seldom more than 5 bar (73 psi).

A high pressure pump is connected to the fluid circulation line and operates as a boosting pump generating high pressure spraying. Advantages of the fluid circulation system, are constant colour, constant viscosity and constant solvent content.

3.5 Spray guns

Most of the airless spray guns available on the market are equipped with carbide needles and seats. They have safety valves and trigger controls. A wide range of easily replaceable carbide nozzles for many different capacities and spray angles are available.

There are also self-cleaning nozzles and extension poles available for various high pressure spraying requirements.

3.6 Pumps

As mentioned before, two systems are available, the electrically operated pump and the pneumatically operated pump.

Both systems are offered in different constructions and sizes. They range from small outputs for the sophisticated hobbyist to large outputs for professional coating operations of contractors and industrial users. They are different in output and pressure.

4. Hot spraying

Coating materials of less viscosity are easier to spray. The viscosity of different types of coating material varies very much. For instance, a top coat will be sprayed at a lower viscosity than a prime coat.

Normally, varying quantities of solvent are added to establish the correct viscosity. Another method is to heat the fluid to adjust the desired viscosity before spraying.

Heating the coating material, therefore, saves thinner and enables the fluid to be sprayed in a more concentrated form. The heated material spreads better and gives better coverage because of higher non-volatile content. A denser surface coat is the result. Hot spraying gives excellent atomization and homogeneous surface coats with high gloss.

As the fluid material contains less thinner, drying time is shortened and the coat settles faster. All these factors reduce the tendency for the coating material to run and increase the production capacity of lacquer drying ovens or chambers. Hot spraying can be combined with conventional, high pressure and electrostatic spraying.

Advantages

- Better coverage, denser coat
- Simpler, quicker application, short drying time
- Lower air consumption when conventional spraying is applied
- Reduced wear, when used with high pressure spray system, because of lower pressure
- Reduced consumption of thinner
- Constant fluid temperature throughout.

4.1 How does it work

The fluid passes through the heater under high pressure. It is heated to the correct temperature and passes on to the gun. During intervals, the fluid circulates continuously in a closed loop. From pump through heater to gun and back to the suction side of the pump. The return regulator on the line from the gun is used to regulate the quantity of fluid circulating back to the pump. This ensures that there will be a continuous flow of fluid at the right temperature reaching the gun, and that overheating of fluid in the heater will be prevented.

High pressure hot spraying with heat enables viscose coating material to be applied at a steady pace, particularly with prime coating material although the combination results in excellent top coats. The method is most widely used in industry, for instance in the manufacture of trucks, tractors, etc.

Of course, hot spray can also be used with conventional spraying systems. Conventional hot spraying results in an excellent finish and is particularly well-suited for applying top coats in the automotive industry.

There are two alternatives of heating the fluid:

- Direct heating
- Heat exchangers

4.1.1 Direct heating

The fluid heater is equipped with an electric heating element, overheating safety cut-out and a plug-in thermostat for heat control. The thermometer indicates the temperature of the outgoing fluid.

4.1.2 Heat exchanger

The fluid is heated by circulation of hot water from a central thermostat controlled circulation system. Several guns can be operated continuously and both conventional and high pressure spraying can be operated simultaneously through a single heating system.

5. Electrostatic coating

Two methods are available:

- Electrostatic wet application
- Electrostatic powder coating

Both methods utilize the electrostatic field lines between the spray gun and the grounded object. The coating material particles are electrically charged to approximately 90'000 volts.

One of the major advantages of electrostatic spray coating is that the coating material is well distributed on the rear surface of the articles as well, though this requires the article to have an appropriate shape: it must not be too wide or too deep or have Faraday cages. Electrostatic spray coating generally results in best coating economy. Losses with powder spraying can be as low as one to five per cent and with wet

application between ten and forty per cent. The high economic efficiency of powder coating is largely due to the fact that the coating material passing the object, can be recovered and reutilized. The electrostatic method is highly suitable for automatic processes and its introduction can, therefore, constitute a profitable rationalization. Suitable articles are steel tubing and frame work constructions, grids, fences and cycle frames. Even non-conductive materials can be electrostatically spray coated, though they have to be specially pre-treated.

5.1 How does it work

5.1.1 Wet coating system

Each coating material is charged when leaving the nozzle of the gun. The material is thus carried to the object to be coated both by the forward velocity of the paint and by the electrostatic field.

5.1.2 Powder coating system

A mixture of air and powder is conveyed from a mixing unit to the spray gun. Each powder particle is charged when leaving the nozzle of the gun. The powder thus carried to the object to be coated both by the stream of compressed air and by the electrostatic field. After spraying, the particles pass through an oven with a temperature of 180 - 330° Centigrade.

Advantages

- Very low coating material losses
- Good wrap-around effect
- Uniform, pore-free coat layers
- High capacity

Electrostatic units are available as manual and automatic systems.

5.2 Coating material circulation and centers

Where material consumption is low or where colour changes are frequent, it is generally quite sufficient to have a pressure feed tank at each spraying station. But as soon as single colour coating is required and used by several operators simultaneously, it becomes advisable to consider whether a circulation system might not be the more rational solution for the coating material supply problem.

With a coating material circulation system, spraying operators whose time is costly, can concentrate on spraying and are relieved of constant interruptions for coat mixing and filling. This sytem not only saves time, it gives uninterrupted availability of coating material of a particular colour and viscosity. This enables spraying operators to maintain a standard coat layer quality and surface finish. The coating material pressure in the circulation system supply line is usually the pressure required for conventional spray coating. For high pressure spray coating a high pressure pump may be connected to any of the take-off points on the supply line. It is thus possible to benefit from the advantages of high pressure spraying and of material circulation. The circulation system can of course be combined with electrostatic spraying and hot spraying. The fairly high installation costs of material circulation system is more than compensated by the rate of production of uniform coating quality and by reduced spillage and lower coating material consumption.

The larger the number of spraying stations in an installation, the larger the number of courses being sprayed simultaneously, the more operators using the same colour, the higher will be the profitability of the coating material circulation plant.

Advantages

- Colour of the right shade and viscosity always available at the spraying station
- Central coating material supply controll by pumps and mixing tanks, installed in one place, the circulation center
- Continuous material filtering minimizes intervals

5.2.1 How does it work

The simplest way of describing a fluid circulation system is to compare with a water or compressed air supply system. The difference is the closed loop system for circulation of coating material.

The air driven pump forces the coating material out of the drum into a circulation pipe. At the spray gun outlet there is a reducing valve to control the coating material pressure supply to the gun. High pressure pump, also compressed air driven, is connected to another take-off point.

It acts as a booster pump and supplies the spray gun with coating material and high pressure. The main flow returns to the fluid drum, which is fitted with a compressed air driven stirrer to ensure that the colour and viscosity of the coating material remains constant.

The coating material centre is suitable where the daily consumption exceeds 250 litres (55 imperial gallons). The pump is mounted on a separate stand pipe and pumps from either of the two tanks. This arrangement enables the coating material to be mixed and filled in one container at any time while coating material is being pumped from the other.

5.2.2 Pumps

There are in general, five factors to be considered when selecting the size of a pump:

- Coating material consumption
- Coating material viscosity
- Total length of piping
- Pressure drop in circulation line
- The dimension of the pipe

The first three items are usually known and the last two generally have to be calculated.

5.2.3 Accessories

In addition to the pumps, the coating material circulation installation includes a large number of accessories. Filters eliminate slowing down due to clogged valves and spray gun nozzles. Pulsation dampers provide an even flow of material, reducing valves and back pressure regulators ensure correct material pressure in each section and the pressure can be clearly indicated on a pressure gauge. Compressed air driven transfer pumps and coating material stirrers are simple and reliable accessories of the circulation system.

6. Automatic spray coating

Surface finishing operations can, in principle, be rationalized in the same way as other operations, and one way of achieving this is by atomization. One of the most important requirements for automatic spray coating is that there should be long runs of similar articles. The choice of the spraying method is guided by the shape and material of the article and the type of coating material to be applied. High economy of operation can also be achieved by proper layout of the finishing department and by material handling in these sections.

Once the utomatic plant has beer set up, the produ tion flows with unchanged capacity and quality day by day. A prime requirement for an automatic plant is reliability while the purchasing price often is of secondary importance compared to the other economic factors.

Apart from requiring less labour per article, automatic spraying results in a higher rate of production and much lower coating materail losses, both factors improving economy of operation.

Advantages

- High capacity, uniform quality
- Low handling and labour costs
- Good economy in coating material utilization
- Better working environment

6.1 How does it work

Automatic spray coating equipment can be arranged in several different ways:

6.1.1 Traversing system

The spray guns, one or more, move on top or underneath the object passing along a conveyor. The gun moves perpendicular to the feed direction of the conveyor. These two movements generate a spray pattern similar to a parallelogram, the proportions of which are determined by the speed relation. The gun unit is powerdriven by electrically, hydraulically or pneumatically controlled units.

The electric drive is a simple and reliable system with extremely uniform motion. Normally, the stroke length cannot be varied and is determined when the installation is planned. Electrically driven automatic spray coating equipment is suitable for most spraying methods.

The hydraulically driven system is extremely uniform in motion and the stroke range can be adjusted. It is, therefore, suitable to operate in conjunction with electrostatic spray coating systems equipped with continuously operating spray guns.

Pneumatically driven systems are simple and reliable but the motion is less uniform. Electrostatic powder spraying is one of the fields of application for pneumatic systems, since evencoat coverage does not depend on the uniformity of machine motion with this spraying method.

6.1.2 Rotary table system

The object is conveyed in a closed loop passing the spray guns, one or more, stationary or moving. The conveyor can additionally rotate the object. The rotating table system is mainly used for smaller articles.

6.1.3 Pendulum system

This is a special version of the transveral spray coating machine, in which the guns describe an arc but keep the longitudinal axis of the spray pattern parallel to the direction of travel at full stroke.

The swinging motion stroke length and speed is controlled by pneumatics via valves. In addition to automatic systems with moving guns, systems with fixed guns are available. This type is particularly suitable for spraying of large quantities of article conveyed at fairly high speeds viz: wooden panels, skis, paper, etc.

6.1.4 The control system

This system controlls the starting and stopping of the guns at the correct point in relation to the object to be coated. The presence of the object can be sensed mechanically, by light barriers, by ultrasonic devices or pneumatic units. A programme unit or an electronic memory transmits the signals to the gun operating devices. The length, width and height of the object can be sensed.

7. Spray booths

To prevent a spread of coating material mist in the coating area of the working place is the main reason for installing a spray booth. The current topical pre-occupation with the environment and increased worker protection has added other considerations. Coating material mist must not be dispersed into the open air. It has to be collected and removed. The work place must be clean and not hazardous to prevent accidents and reduce the risk of occupational diseases. The fire risk is reduced when the air contains smaller quantities of coating material and solvent.

A clean, well arranged place of work also contributes to increase the production capacity and a correctly designed spray booth is essential for surface treatment of a high standard.

7.1 How does a spray booth work

Modern spray booths are predominantly of two basic designs: wet separation and dry separation.

Wet separation is the most effective of the two and should be applied in connection with continuous spray coating. From any point of view this is the best solution, having a degree of separation of 99.9 per cent. The coating material laden air is exhausted out of the spraying area through a small gap in which the air velocity highly increases. The water curtain at the spraying site crosses the passage of the air. The water, containing chemicals is casting down spray mist mixing with the coat material laden air. On the other side of the gap the mixture expands sharply and in the turbulence thus formed the air, is washed and the coat material particles are broken down chemically. The cleaned air is exhausted upwards whilst the paint-water particles fall into the water basin of the booth.

Dry separation has a very much lower separation efficiency, normally between 40 and 70 per cent depending on spray material and the booth design. This kind of booth is, therefore, best suited for applications where spraying is not continuous. Coating material separation takes place in a labyrinth trap in which the fluid laden air is forced to pass through narrow slots. The air velocity increases, the heavier particles strike the traps and adhere to them. The cleaned air is then exhausted out of the booth.

7.2 Coat drying

In order to ensure that the final result will have the high quality surface required, a number of different factors have to betuned to each other: Pre-treatment, coating material, spraying method, the material of the object to be coated and the drying method.

Two drying methods are common: air drying and oven drying.

7.2.1 Air drying

Air drying takes place at room temperature which for most materials results in slow drying. It is a simple method which only requires clean premises with moderate air humidity, and it, therefore, suits processes where the rate of production is low. To force drying, temperature between 25 to 100°C are used. Standard coating materials for air drying are

forced dried at aohut 40°C, whilst special coating materials forced drying are usually intended to be dried at temperatures of 80 to 95°C. A typical field of application is repair coating of motor cars, as 80°C is the lowest temperature for drying the coating material and 95°C the maximum permitted temperature for the plastic rubber components of the car.

7.2.2 Kiln drying

In kiln drying chambers temperatures of 100°C and higher are used. This method enables coats with particularly good properties, such as high surface hardness and excellent adhesion to be applied. Kiln drying combines well with automatic spraying methods and contributes to even, high quality and increased rate of production.

Ovens

There are two types of ovens, convection ovens and radiation ovens. In convection ovens, drying is caused by heated air. A convection oven may be one of the three types:

Chamber oven

A completely enclosed space except for circulation and exhaust outlets. Suitable for lower rate of production.

Tunnel oven

A tunnel oven has the form of a long chamber oven equipped with a conveyor.

Hump oven

This type of oven is also open at either end, but provides simple and effective screening of the hot air by having the conveyor opening positioned below the level of the heating section.

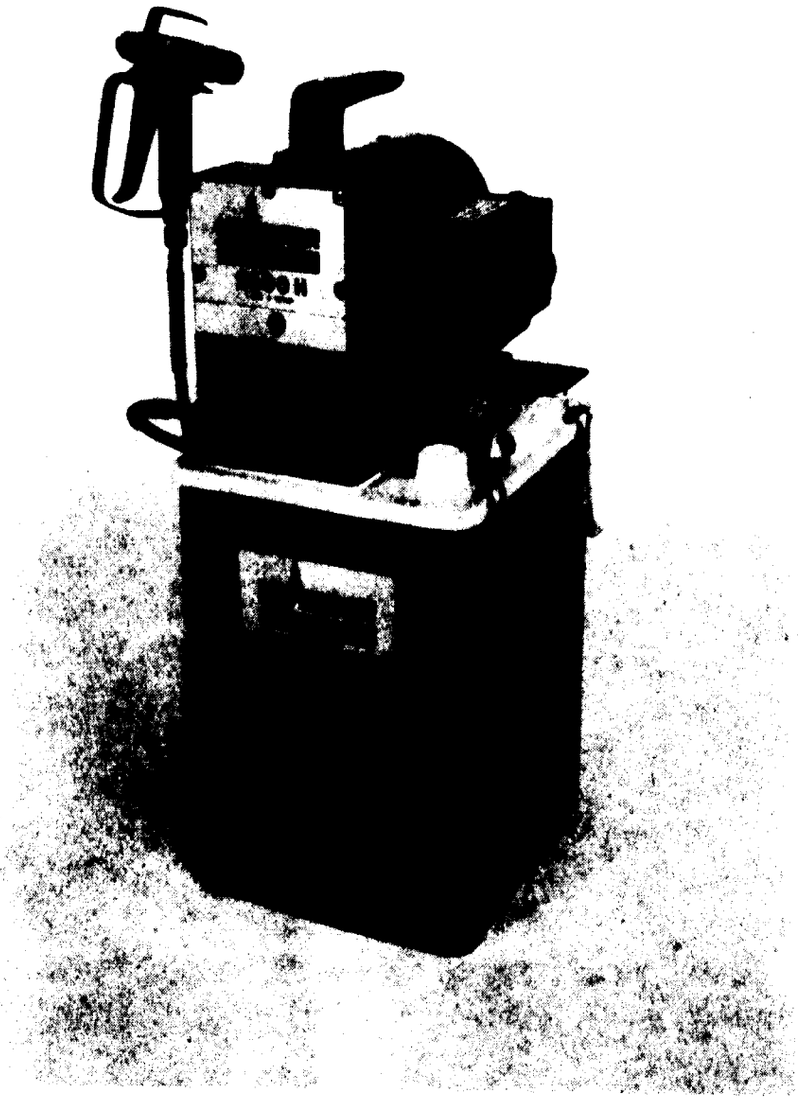
Infra-red ovens

Infra red ovens are heated by infra red radiation. The wave length range of infra red radiation is 7 microns. The infra red rays are absorbed by the coated object increasing the temperature. Different wave lengths generate different heat levels. Different materials absorb different amounts of heat. There are three types of infra red radiating elements, and they are all fitted with reflectors to concentrate the radiation to the desired direction:

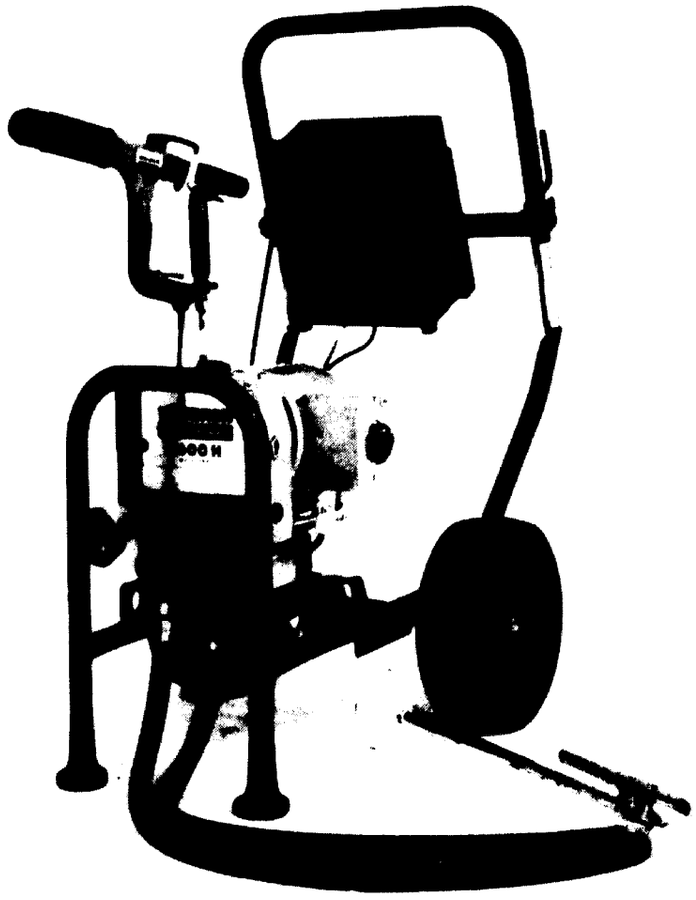
1. Dark radiator
2. Infra red lamps
3. Ceramic gas burners

The radiation from an infra red lamp with a filament temperature of approximately 1930°C has a peak of a wave length of 1.2 microns whilst a dark radiator with a surface temperature of approximately 650°C has a radiation peak in the region of 3.2 microns.

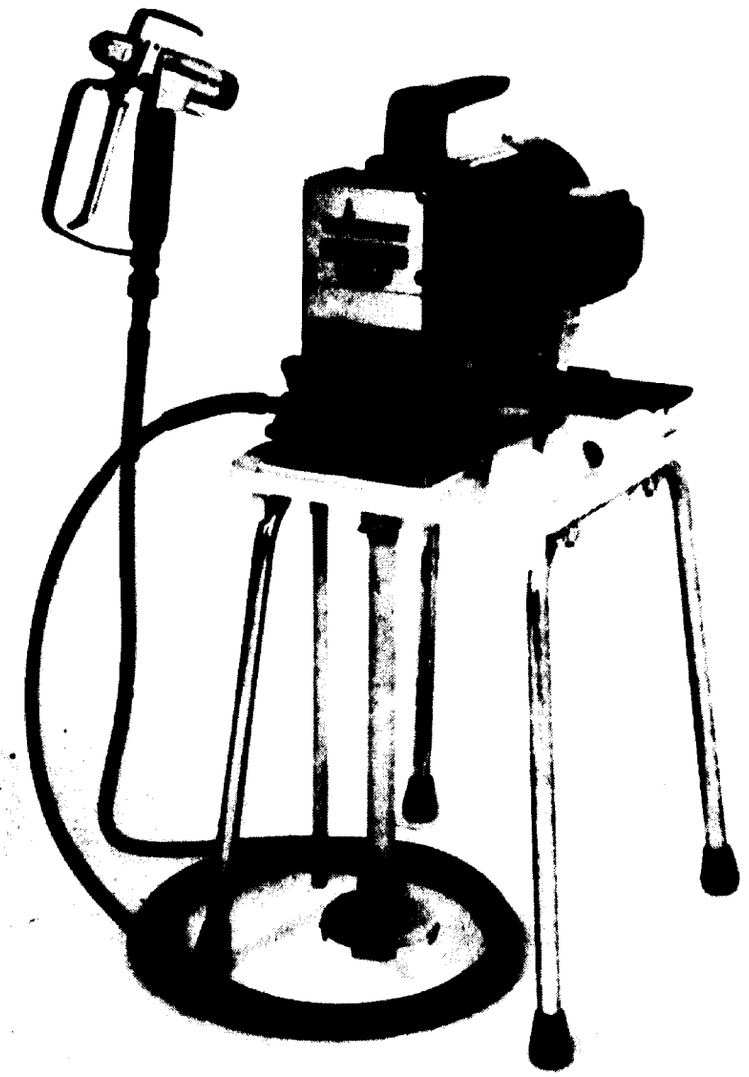
The infra red absorption of coating material is generally best at 3.5 microns, and the dark radiators are, therefore, the most suitable type. On the other hand, coating materials to be dried by infra red lamps, must be specifically formulated before coating.



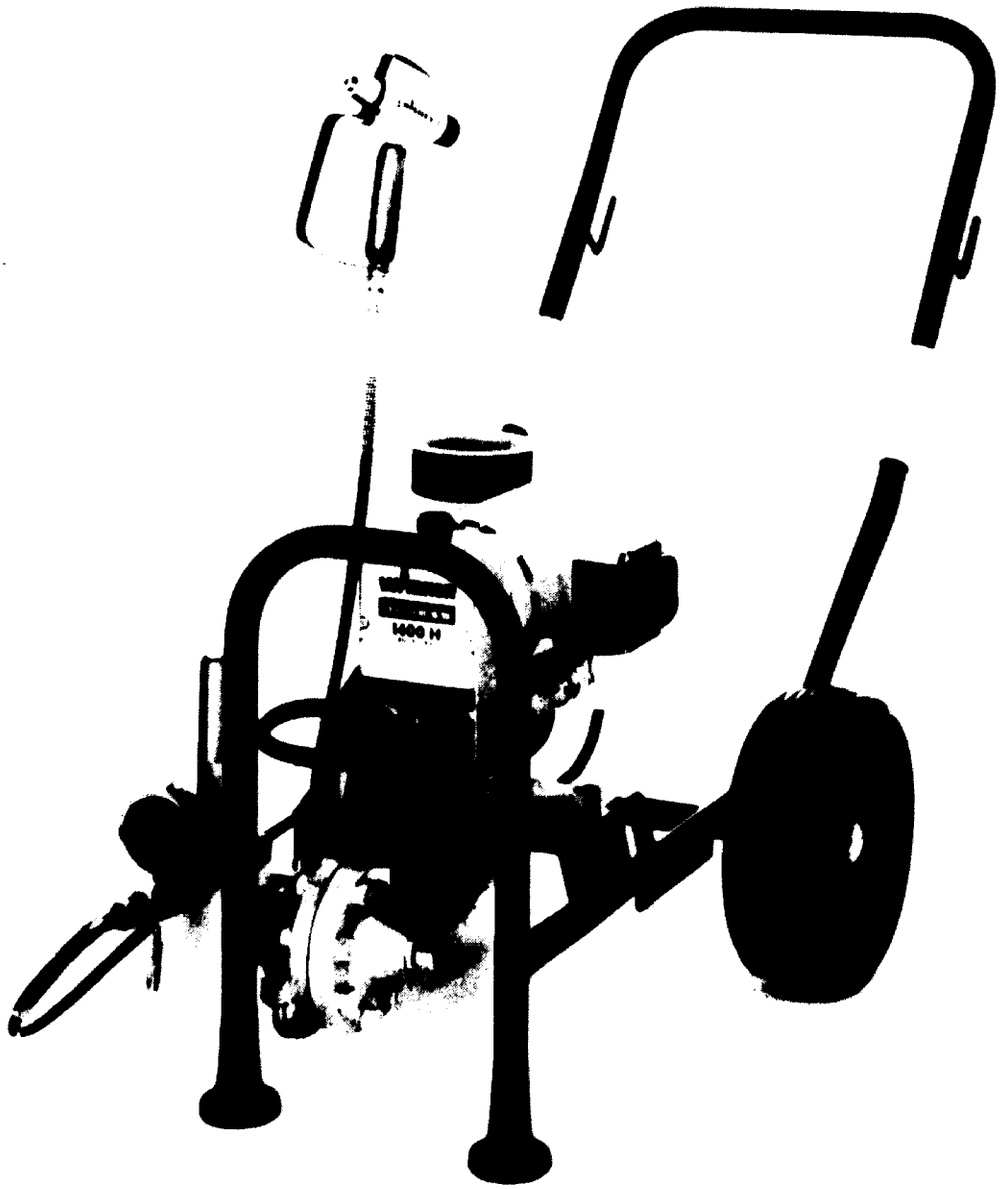
Picture 1: Airless spray system mounted on a 37 liter tank



Picture 2: Airless spray system with compact eletrostatic control mounted on trolley with flexible suction unit to be used on coating material drums

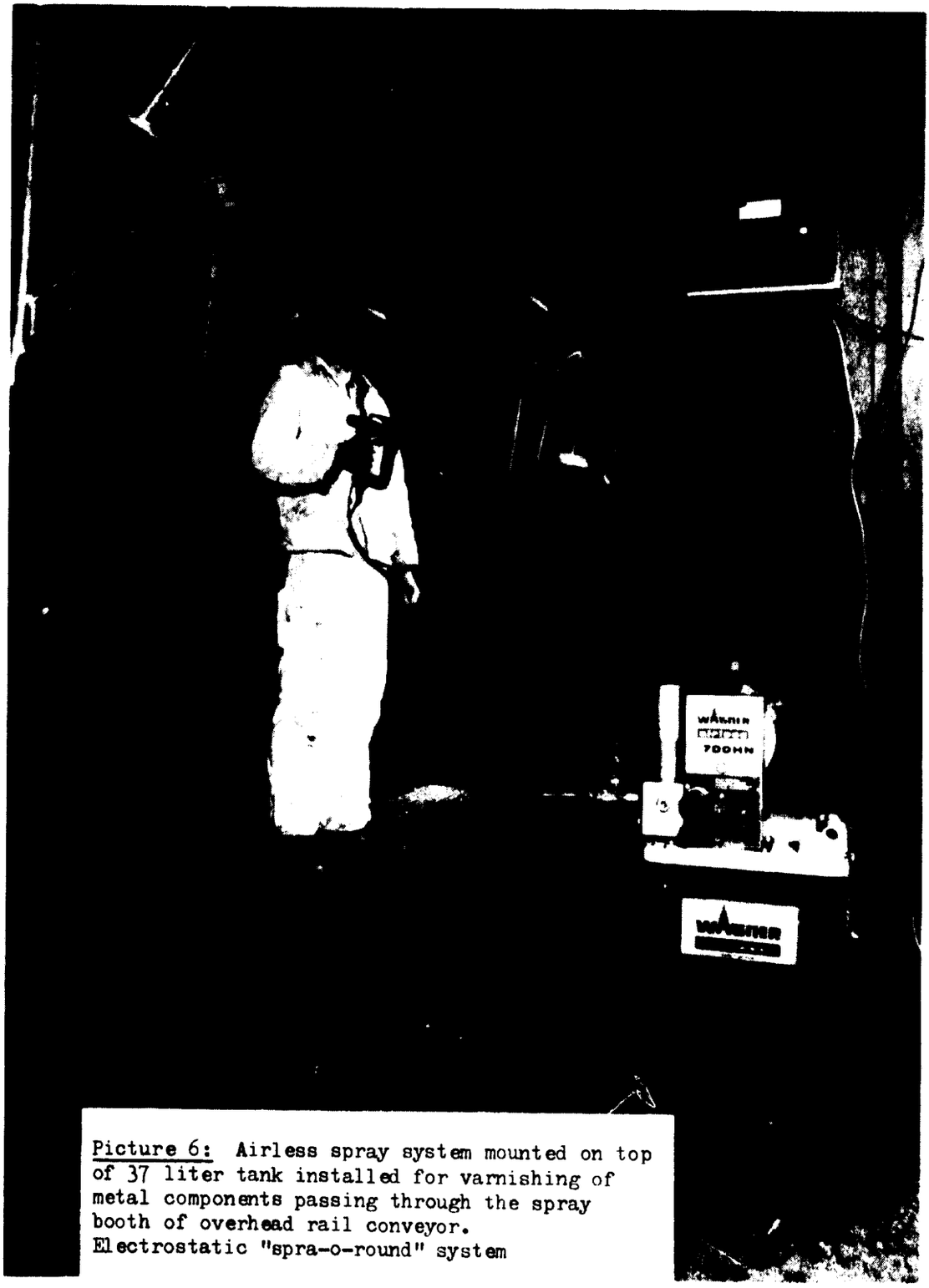


Picture 3: Airless spray system table mounted with fixed suction unit



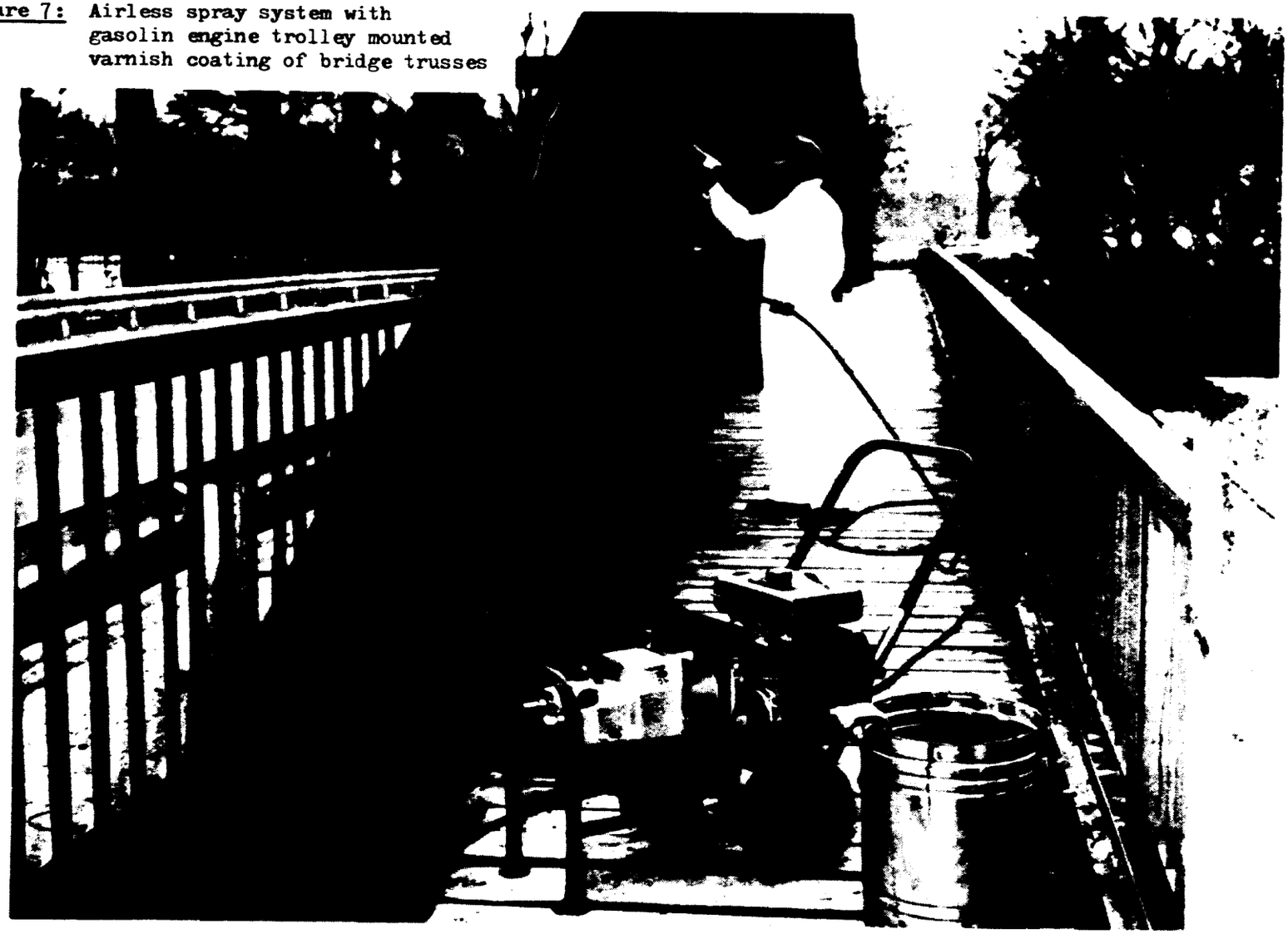
Picture 4: Airless spray system trolley mounted with flexible suction unit

Picture 5: Airless spray system on table stand. Operator spraying sawn studs with preservation material from drum



Picture 6: Airless spray system mounted on top of 37 liter tank installed for varnishing of metal components passing through the spray booth of overhead rail conveyor.
Electrostatic "spra-o-round" system

Picture 7: Airless spray system with gasolin engine trolley mounted varnish coating of bridge trusses



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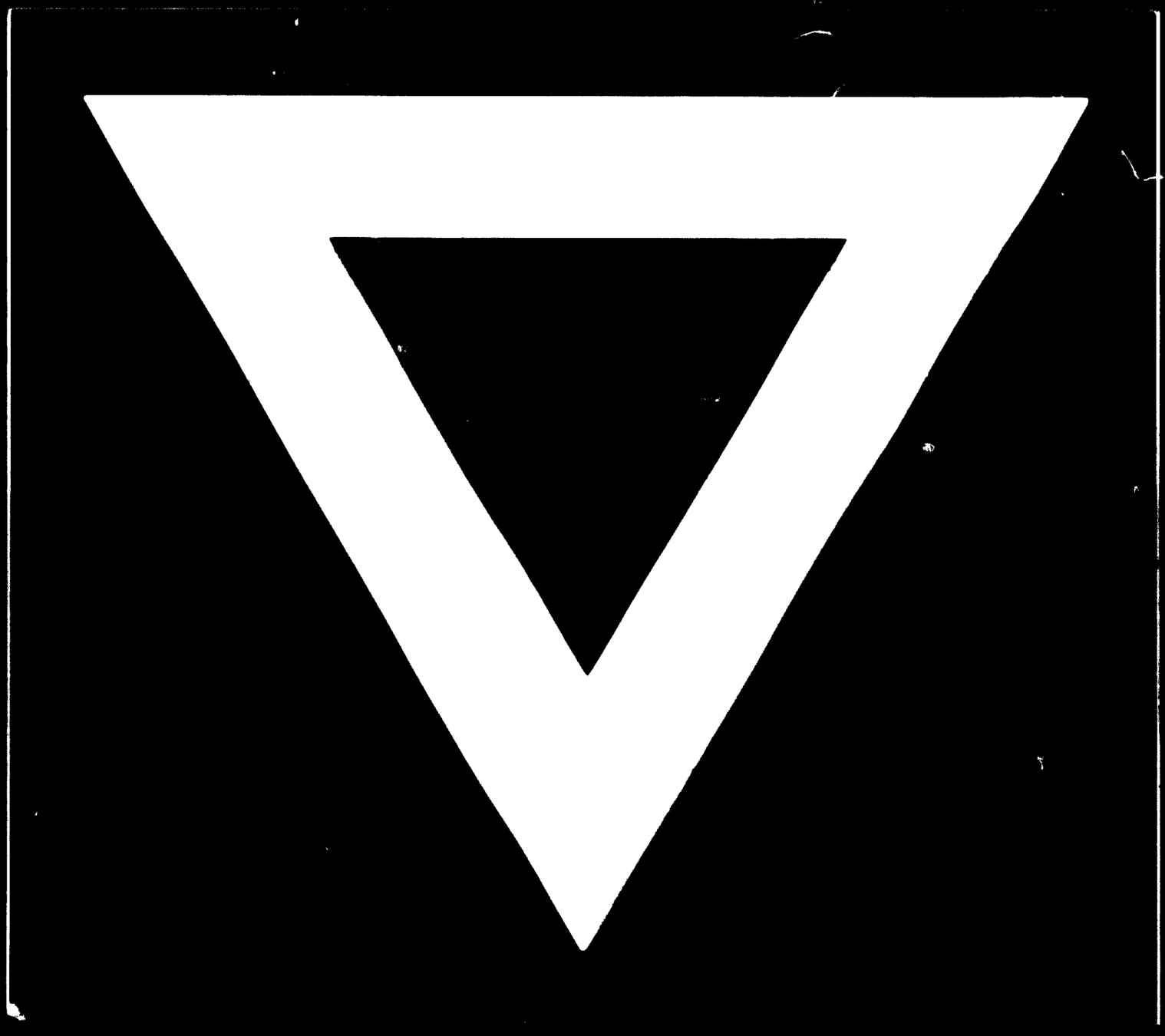

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