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OPERATOR'S MANUAL

AVIAN DELIVERY SYSTEM

The system described in this manual offers a method for delivery and retrieval of small objects to normally inaccessible locations on buildings or other structures. The system utilizes a trained raven as the delivery vehicle.

The purpose of this manual is to provide guidance to trained bird handlers in the maintenance of the carriers and utilization of the system. It is not intended as a substitute for on-the-job practical training of a handler and cannot be expected to serve as a training manual for utilization of the system by unskilled individuals.

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I. Introduction - Description of the System

The package delivery system has been developed as a means of placing a small device upon a window sill or other ledge of a building, and also of recovering the package. The transport vehicle is a trained raven.

The bird has been taught to take the package in his beak and to fly with it to the proper target surface, place it on the target surface and return to the cage from which he made his outflight. Similarly, the bird may be released to recover the package. The maximum package weight that the bird can reasonably be expected to carry weighs about 40 grams (10% of birds body weight). Package dimensions can vary considerably but are limited to a size which the bird can readily grasp in its beak. Packages used in routine training measure 3 x 1 x 3/4 inches.

Training has been principally directed to conditioning the birds to making outflights from a cage located just inside a window. Birds have also been launched from a cage in the back of a station wagon and camper. The target must

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be within line of sight from the launch point. Maximum ranges of 300 feet under ideal conditions have been achieved.

To guide the bird, the red beam of a helium-neon laser is projected to mark the target surface. Typically a projected spot is aimed at a point an inch or two below the target surface. A motor driven shutter interrupts the laser beam at a frequency of approximately two cycles per second. The bird has been trained to fly to the flashing red spot which appears upon the target building. The laser beam need be projected only during the outflight.

The return flight is guided by the presence of a small high-intensity table lamp which is turned on at the instant the bird properly places a package or picks up a previously placed package. The table lamp serves two purposes. Turning on the lamp signals the bird that he has performed properly and that he will receive a food reward upon return to the launch cage. The lamp is also a "beacon" reminding the bird of the location of the launch cage.

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The small, low power lasers used in the system emit about one milliwatt of light energy. The reflection of the projected red spot is not visible in broad daylight. Missions, therefore, are generally limited to dawn or dusk conditions, although successful demonstration missions have been conducted at night in lighted city streets. It has not been possible to record precise data concerning the range of acceptable ambient light conditions because of the wide variations of reflectance of common building materials. As a rule of thumb it can be stated that, if both the target landing surface and the projected spot can be clearly seen by a human observer at the launch site, ambient light is satisfactory for a mission flight.

The on-site portion of an actual operation might be conducted as follows: On a table inside the selected launch window are placed the launch cage and the table lamp. These objects are located approximately one to six feet from the window opening. The cage is equipped with a swinging latched door at each end. One of the doors faces the window. The laser is located at any convenient spot so that

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it may be aimed at the target point. The bird is transferred from a carrying container to the launch cage. The laser is aimed, by means of simple open sights, at the target. Window curtains, if any, are drawn aside and the window is opened. The laser is switched on permitting the beam to mark the target. The front door of the launch cage is opened and, as the bird emerges, the package is held so that the bird grasps it. (Photos 1 & 2) The bird flies to the target surface and, when he lands, the laser is turned off. At the instant the package is seen to be properly placed, the recall lamp is turned on. The bird flies into the cage, receives his food through an opening in the side of the cage, (Photo 3) and the front door is closed. To recover the package, the procedure is repeated except, of course, that the bird flies out carrying no load. The laser spot guides him to the package location. At the instant the bird is seen to have picked up the package, the recall lamp is turned on. As the bird re-enters the cage, he drops the package to take his food reward. If the launch cage is placed a considerable distance back from the launch site

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window (up to 6 feet) the cage itself may not be in line of sight with the target. In such a case, the bird may not be able to see the laser spot until he reaches the sill of the launch site window. Such out-of-line-of-sight placement of the launch cage has been demonstrated as feasible. The recall lamp, however, must be in line of sight from the target so that the returning bird will be properly guided. The launch cage and recall lamp, obviously, cannot always be positioned in the same location in the launch site room. A returning bird will home in to the recall lamp, set some distance inside the window and may be fed near it. Once the launch site window is closed, the bird has been essentially secured and can be returned to his cage as soon as is convenient.

A window from which a bird is launched should, where possible, be curtained except for the actual open portion to eliminate the risk of a returning bird crashing into a transparent window pane.

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II. The Carrier

A. General Treatment and Handling

The carrier, crow or raven, has been tamed and associates food and his general well being with humans. The bird must never be handled roughly or punished in any way, except by the properly controlled withholding of food during training and exercising. Proper housing, food, and exercise must be provided to keep the birds in top physical and mental conditions.

It is frequently necessary to pick up or carry a bird as when transferring him from one cage to another or weighing him, or perhaps when recovering a sated bird at the end of an exercise session. A bird can be grasped in the hand by gripping one leg between the thumb and forefinger allowing the bird, in turn, to rest the other leg on the wrist. The foot of the grasped leg should be permitted to hold to the second or third finger. (Photo 4) Movements toward a bird to be picked up may be fairly rapid, but should not be abrupt or jerky as sudden movements may startle the bird.

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As a bird is held, the grip should be firm but flexible. One should "give" with the bird's movement if he turns or attempts to fly. Birds' legs are fragile, thus a rigid grip risks danger of a damaged leg joint or broken bone. Some birds do not permit a handler to grasp a leg or do not readily perch on the handler's arm or hand. Such birds are more easily grasped by two hands gently encircling the body.

Birds perched on the arm can often be held in place by holding the bird's identification band. The looseness of the band permits the bird to turn with minimum danger of leg injury.

B. Housing and Transport

The principal problems in transporting, storing, and maintaining the system concern the birds.

Good feather condition is essential to the usefulness of a bird. Wire mesh cages or pens should not be used as they tend to cause severe damage to tail feathers. Necessary

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cage openings can best be covered by round vertical bars spaced about one inch apart. However, ventilation slots located high on the walls or in the tops of cages may be covered with mesh if they are well above the head level of the bird as he perches in the cage.

To prevent feather damage, shipping-living cages should be as large as reasonably possible. Cages measuring 27" wide, 26" front to back and 21 1/2" high have proved to be satisfactory. Cages should be equipped with dropping trays in which litter, e.g., "Kitty Litter", can be placed. A wooden dowel about 3/4" in diameter placed above the tray provides a perch for the birds. For shipping, a cup for food and another for water should be attached inside each cage. Cages of this type and size are satisfactory as living cages in which birds may be housed for long periods of time. When such a cage is used as a living cage it is best to attach feed and water cups outside the cage just below an opening through which the bird can reach. External cups are easy to clean and allow more free space inside.

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Plywood is a satisfactory material for cage construction. However, if a cage is to be occupied for other than short periods of time, plywood walls should be lined with a hard surface material like Formica. Formica surfaces are easy to keep clean and cannot be splintered by a bird's powerful beak.

For transport over long distances birds are best moved by air to shorten time in transit. For travel time, not to exceed about five hours, and where space is limited as in a small foreign car, cages with interior dimensions of about the size of an 18" cube can be used. Small cages should be used as little as possible to avoid feather damage. Food and water cups can be omitted from small cages provided birds are given water immediately before and after travel, again not to exceed five hours.

Caution: Birds should not be left in closed cars exposed to summer sunlight as temperatures considerably above 100 degrees F. may develop which could seriously harm or even kill the birds. During transport periods greater

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than about 24 hours, birds should be fed as nearly as possible in accordance with normal feeding procedures.

It has been found that all equipment needed for a mission can be packed in ordinary suitcases, except for the large cages. Larger shipping-living cages are particularly bulky. For transport in a small car, a folding living cage has been developed. Unfolded and assembled, it forms a cage satisfactory for long-time housing.

C. Diet and Care

Because the birds work for food rewards, each bird's food intake and body weight must be carefully monitored. Birds in training are weighed almost daily, principally to avoid over-deprivation, but also because an unexpected weight loss may be a warning of illness.

The basic item of diet is a mixture called "crow salad". The recipe is on the following page.

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Ingredients	Approx. % by Weight	Recommended Mixture
fatty beef	82	900 grams
beef or pork liver	2	25 grams
canned corn	2	25 grams
fresh or canned tomatoes	2	25 grams
lettuce	2	25 grams
fresh carrots	2	25 grams
raw egg with shell	2	1 egg
cottage cheese	2	25 grams
whole wheat bread	2	25 grams
bone meal	2	25 grams
Vitamycin*	2	2 teaspoons

*Vitamycin is a vitamin and mineral preparation produced by the Dow Chemical Company, Indinapolis.

With a conventional hand operated kitchen food grinder grind: liver, corn, carrots, egg shell, bread, lettuce, tomato. Add these to the beef, egg, bone meal, and Vitamycin. Mix thoroughly. The mixture must, of course,

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be refrigerated. This amount will feed two ravens for about a week.

The exact proportions are not critical. In scaling down our standard training farm quantities, for example, we did not suggest a fraction of an egg!

On the average, each bird needs about 50 grams of crow salad per day.

Crow salad has been prepared in freeze-dry form. The dry material is mixed with water in approximately one-to-one proportion by weight. After thorough mixing the product is of a watery consistency, but it thickens after being allowed to stand for several hours. Experiments with several birds indicate that the freeze-dry mixture can be fed at the same rate as fresh crow salad to maintain constant body weight. The freeze-dry product is not as effectively utilized as the fresh product. Do not use freeze-dry food except under conditions where it is not practical to supply the food in fresh form.

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Drinking water should be available to a bird at all times in his living or shipping cage, with the exception that, for convenience in short time travel, water may be omitted from the shipping cage.

Although the feeding of a fully trained bird may differ somewhat from that of a bird in training, a knowledge of the trainer's feeding procedures should be useful to those charged with the care of a mission trained bird.

Experience with each bird reveals the maximum weight at which the bird will work reliably. Greater weight results in reduced hunger drive and reluctance to work for food rewards. Significantly lower weights present unnecessary risk of weakness and poor resistance to disease. A tolerance of plus or minus 20 grams is ordinarily acceptable.

During the training period, which in some cases has extended for years, the optimum working weight may change, particularly with changing seasons. Warm weather commonly

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requires a reduction in weight, cold weather permits it to be increased.

To insure adherence to the maximum permissible weight policy, feeding programs are purposely directed slightly toward over-feeding. If performance of a healthy bird becomes sluggish or unreliable, a bird's food intake is limited until a good working weight is again reached.

A bird typically receives about 50 grams of crow salad per day. On working days much of this food is received as reward for performance. The remainder is fed at the end of the day. Birds are weighed daily except on week-ends and records of weight and performance are kept. Adjustments for off-optimum weight are usually made by fairly small changes in the daily food allotment. Abrupt drastic weight losses are avoided as much as possible. Weight reduction, when required, is limited to a rate of about 10 grams per day. For example, an overweight sluggish bird may be dropped to a 40-gram daily intake, then, if necessary, to 30 or even 20 grams until the bird is again

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performing well. The diet of an underweight bird is increased in similar increments.

For convenience in rationing crow salad, a bird's allotment is weighed out at the beginning of the day and placed in an individual container assigned to that bird.

On non-working days, usually Saturdays and Sundays, a bird is daily hand fed all that he will eat in one session. The remainder of his allotment, if any, is placed in the feed cup for consumption when the bird is hungry again.

Commonly, weekend feeding of a bird results in some weight gain as the bird is idle and thus burning less fuel. As a result performance on Monday, particularly in the morning, is often poor. Birds are usually not pressed for top performance on Monday. By Tuesday, and during the remainder of the week's working days, weight and the related hunger drive is adjusted to a satisfactory level.

Not unusually a bird will actually gain weight during the working days of the week. If such a gain is significant,

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20 grams or more, the weekend ration may be reduced.

Because weight is an indication of a bird's health, birds should be weighed frequently on accurate scales and weight records kept. Inexpensive scales of the type known as "dietetic" scales are easily obtained and are easy to pack for shipping. Unfortunately they are often inaccurate and, worse, their readings tend to drift. If such scales are used, a set of standard weights should be provided and frequent calibration checks made.

In normal training, maintenance of high drive levels is avoided. Nevertheless, such drive levels do temporarily increase the probability of good performance and should be employed when "the chips are down".

To attain a temporary high drive level without serious risk to health, the following procedure should be followed: This procedure has proved satisfactory prior to important demonstrations involving mock missions. If a bird is at or near optimum weight he is fed a normal days' ration 48 hours in advance of the anticipated demonstration time.

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No more food is given except for the little that may be earned in a very few test flights. There is some evidence that it is best not to exercise the bird at all during approximately the last 16 hours preceding the demonstration. At the end of the 48 hour period it can be expected that the bird will be eager to work and will be, because of rather extreme hunger, motivated to risk flight in an unfamiliar location that might otherwise present stimuli disturbing to him at only moderate drive levels.

Obviously, one cannot always anticipate need for a bird's services at precisely 48 hours in advance. Fortunately there is considerable tolerance. A bird in good health can withstand 24 to 30 hours of deprivation starting at almost any time even though the start of such deprivation may coincide with a slightly underweight condition. If a postponement delays a scheduled flight, for a day, somewhat scanty feeding (typically about 30 grams), but with actual amounts determined by bird weight will keep the bird "at the ready" 24 hours before the newly scheduled flight.

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In premission periods, slight weight losses are acceptable. Gains are not. Some additional day's delay may be possible by similar 24 hours advance feeding, but a long-term delay, four consecutive days, for example, might result in weight loss that cannot safely be allowed to continue.

In recent training, it has been found that birds can safely fly while tethered to a lightweight line. Tethering has greatly reduced fly-away losses that previously occurred with some birds in their early outdoor training sessions. Other losses occurred even with advanced birds under low hunger drive levels.

The line is 10 pound test monofilament fishing line paid out from a conventional closed-face spinning reel (Zebco model 800 for example). (Photo 5) A small fish-bait snap swivel is permanently attached to a leg band. (Photo 6) A similar snap swivel is tied to the free end of the line, thus the line can easily and quickly be attached to the bird's leg before the bird is released for flight. A bird straying

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from his proper flight path can be gently brought to earth by careful braking of the line as it pays out.

It is inherent in the design of a spinning reel that the line is subjected to twisting. To reduce the resulting curling or kinking of the line, it is frequently unreeled by hand and pulled out to its full length. The stretched out line is held taut by its outer swivel which allows the line to untwist. The straightened line held taut is reeled in again, ready for use.

Birds in advanced outdoor training must, of course, make many untethered flights. Because birds in training cannot be constantly at the high degree of hunger that would be imposed for an actual mission, there is a higher risk of loss. If there is reason to believe that a bird may not be fully motivated to stay on course, tehtered flights are made at the start of a training session so that the bird's behavior can be judged. Only if the bird appears to be working well are untethered flights then permitted.

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Periodically stimulating a bird to preen helps him to maintain good feather condition. Once or twice a week the bird should be wet down with water from a spray bottle to induce preening.

D. Exercise and Maintenance of Trained Behavior

To keep fully trained birds "in storage" involves, ideally, a program similar to the training schedule already described.

It is desirable that a bird be given as much exercise as possible. Not only does exercise help maintain flight strength, it also assures a fair approximation of the ideal food consumption. Most of the bird's food is that which he is willing to work for, thus regulation of the diet is determined automatically to a considerable extent.

It is understood that, in "storage" locations in foreign countries, security requirements may make it impossible to find ideal exercise areas. Outdoor exercise at mission ranges is preferable to either indoor or short range exercise, but exercise can be given indoors at short range if

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there are no alternatives. Outdoor untethered flights should be few in number and made only with a bird that seems eager to work.

Package placement and retrieval in exercise not only keeps a bird in flying trim but also maintains load carrying ability.

For indoor exercise the target platform can be a table at one end of a hallway and a launch cage and recall lamp at the other. Even in a moderate sized room some valuable exercise can be given. Exercise areas and target locations should be varied as much as possible. Exercise sessions are conducted like miniature missions except that more strict requirements are enforced in terms of package placement. For example, in a real mission run, a placement at the end of a sill opposite the end marked by a laser spot might be acceptable. In an exercise run it should not be rewarded.

If a bird should go astray in a mission flight it might be necessary to recall him to the launch cage. During exercise

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flights the recall lamp should not be used following any improper response unless it is absolutely necessary as it might be in outdoor exercises. If the bird does not return without recall, it is best to return the bird by hand. The recall signal has, in training, been associated with food reward given upon return, thus the recall signal alone has some rewarding effect. To use the recall signal following an improper response tends to strengthen that improper response. A sated bird will not perform well at any range. Exercise of a bird showing signs of satiation should be halted.

An audible recall signal, the click of a toy "cricket", was also used in training the birds. This signal should be used only when necessary to recall a bird that is not responding well to the recall lamp.

Crow salad is used for food rewards. A pinch of food, about 1/4 to 1/2 gram, is presented to a bird when it returns to its launch cage following correct performance and recall. The timing of a reward is critical. Reward begins with re-

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call. The recall lamp should be lighted instantly when a bird places a package properly, or, on retrieval, when a bird has picked up the package.

Food given as reward is, of course, a part of the bird's diet.

In spite of the advantages of frequent exercising it is not an absolute essential. If a day or two of regularly scheduled exercise is omitted the bird may simply be fed, preferably at the time of day an operation is likely to take place. The bird should be fed the amount that he would normally eat if he were being exercised, or slightly less. If the experienced handler must be absent on an exercise day it is best to omit the exercise program and to leave only feeding to less experienced caretakers. Exercise sessions are in effect miniature missions, so improper rewarding can adversely affect the behavior required for real missions.

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E. Illness and Treatment in the Field

In most instances, the raven is a hardy bird. All but the most extreme temperatures have little effect. High temperatures may cause a little sluggishness and slightly lessened endurance while low temperatures seem to heighten activity and sharpen the bird's appetite. However, it is wise to provide the bird shelter from direct exposure to sun, wind, and weather extremes.

It is recommended that the diet of crow salad be adhered to when practical, especially when placing the bird on a drive prior to a mission. The majority of the health problems of ravens in training for a mission stem from inadequate nutrition. While it is important that the bird be hungry enough to work well, it is imperative that the health of the bird be maintained by adequate food. Adhere closely to the feeding instructions included in this manual.

An unexpected weight loss of, for example, 20 to 30 grams, such as one not due to an imposed deprivation, or a failure to gain weight quickly following a necessary deprivation,

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may be an indication of a stress condition. Cessation of exercise plus full feeding (all the bird can eat twice a day) is called for until weight is regained. Freedom to fly about in a closed room may also help. (Stress has been an occasional cause of death among crows, in training. Post-mortem examinations have commonly revealed enlarged adrenals, accompanied by no other indications of illness. The incidence of stress conditions has been lower with ravens, and when it occurred recovery has usually been rapid.)

Like humans, the raven faces many types of environmental hazards and diseases. Fortunately, these hazards and diseases are seldom encountered; not so fortunately there will be little you can do in the field to effect a cure or even diagnose the disease.

In the case of the more serious illnesses, the first indications will be a loss of appetite followed by a paling or blanching of the normally bright pink inside lining of the bird's mouth and a loss of gloss or sheen of plumage.

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Sometimes sneezing or coughing will occur. The bird feces may become very runny and almost clear rather than the normal white and olive or brown excreta of a pasty consistency. Occasionally, however, the course of the infection runs fast and the only thing you may notice is the bird will not eat or is reluctant to eat. Do not wait more than a day to begin treatment if the bird goes off its feed or exhibits any of the above described symptoms. Place the bird on a full feed ration. Emphasize the foods you know the bird prefers. Live food, such as minnows or worms, may help stimulate the appetite. Administer Sulmet* in drinking water (two tablespoons, or one fluid ounce, to one gallon of water) for a period of five days. Discontinue treatment for three days, then administer again for three more days. To assure that the bird drinks the medicated water make it available to him for only about six hours per day, preferably in the morning. Letting the bird go without water for the

*Sulmet is a commercial sulfa preparation made by the American Cyanamid Company.

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remainder of the time will build up a strong thirst drive. Sulmet medication is about the only treatment practical in the field.

Occasionally skin growths similar in appearance to warts may appear on the legs and around the bill. Unless the growths become extensive in number or very large, they do no real harm. If a mission is imminent, ignore them. If you will have the bird in your possession for some time and no mission is planned, you may burn off the growth by carefully applying silver nitrate solution with a swab. As needed, peel off the dead tissue and reapply silver nitrate.

All in all, it is best to prevent illness rather than treat it. Be sure the feeding schedules are adhered to. Be sure to use crow salad, or, if this is not available, supplement the diet with vitamins. Do not unnecessarily expose the birds to weather extremes but do supply adequate ventilation.

Of perhaps greater danger to the raven under field conditions is traumatic injury or the ingestion of dangerous substances. If the bird receives a broken wing or broken neck there is

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little one can do to correct the injury. A broken leg may or may not incapacitate the bird depending on the site and extent of the break. A clean break between the leg joint and the foot may be splinted with any lightweight material--match sticks, a length of straightened paper clip wire, etc., secured over the break with tape. A break at the joint is very difficult to set and the injury would probably keep the bird from performing. Immediately after the break is set, the bird might perform all right, but it is not recommended that this be tried unless absolutely required. Regardless of the nature or location of the break, the bird should be given as much time as practical to rest and recover from the injury. When an operation is imminent try a dry run with the bird under secure conditions. It is conceivable that a bird with a severely broken leg or other extensive injury might still be able to perform satisfactorily.

Birds in general, and ravens, in particular, will ingest just about anything they can get into their mouths. Avoid keeping loose objects or harmful substance near the birds.

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If the raven does swallow something harmful, first aid treatment is difficult if not impractical. Often the bird will regurgitate the material spontaneously. Here again, prevention is more effective than treatment.

Feather damage (broken or ruffled feathers) is best avoided but occasionally occurs in spite of the operator's best efforts. Broken or frayed body or tail feathers should be left alone. They will regenerate soon enough and the bird can perform satisfactorily with some damaged body and tail feathers. The wing feathers are a different matter. Loss or damage of wing feathers degrades severely the bird's flight capability. If wing feather damage is noted just prior to a mission, fly the bird to determine if the bird is still capable of flight. Be sure to test the bird weighted with the load it will be carrying during the mission. If the bird seems to fly sufficiently well do not disturb any feathers. If the bird seems to have difficulty flying, set the bird aside, maintaining working weight and exercise sessions if possible. Serious feather damage requires that a bird be dropped from mission ready status.

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III. Hardware

A. Cages

Two types of folding cages are used in transport, housing, and operational use of the bird. These are (1) the large plywood shipping-living cage and (2) the operational aluminum launching cage, which doubles for a short distance shipping cage.

The dimensions of the shipping-living cage, assembled, are 27" wide, 26" front to back, and 21-1/2" high. Folded, the cage requires packing space only 9 1/2" high with other dimensions unchanged. It weighs 37 lbs. A pull-out dropping tray may be filled with sand, shavings, or other absorbent material for cleanliness and odor control. A pair of cups for feed and water clamps to the vertical bars of the door. These cups may be fastened outside when the cage is no longer in transit. Openings in the door grill permit a bird to reach through to the outside cups. The external placement of the cups allows them to be filled and cleaned easily, and eliminates from the interior of the cage a possible haz-

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ard to the bird's feathers. (Photos 7 & 8)

An aluminum launching cage has been constructed. The walls of this cage fold flat against the top permitting top and sides to be placed inside the tray which forms its bottom. Assembled, the cage measures 21 1/2" wide, 23" front to back, and 17" high. Folded, it measures 20 1/2" by 22 1/2" by 2 1/2". The compromise dimensions of the cage offer the possibility of use for three purposes: as a shipping cage, a living cage, and as a launch cage. Doors at each end and a wooden insert to raise the floor level to the bottom of the front door provide the requirements for a launch cage. Packed with its floor insert, the folded cage measures 4 3/4" high. With the floor it weighs 28 lbs. (Photos 9 & 10)

B. Black Box Bird Carrier

The black box bird carrier, 18" x 7 1/2" x 13 1/2" is ventilated by baffled, light-tight openings (Photo 11). Because of complete darkness in the box, a bird carried in it makes

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little or no noise. This box should only be used when absolutely necessary, such as when carrying a bird into a building. Birds should not be left in the box for longer than 15 minutes.

C. Weight Scales

Accurate scales are desirable for weighing the birds. Unfortunately, good laboratory scales are bulky and delicate. A substitute is the small, simple type of spring scales known as "dietetic". The readings of such scales often tends to drift, so it is advisable to use a set of calibrating weights to permit checking and adjustments of the scales.

D. Laser and Accessories

A flashing red spot produced by a helium-neon laser is used to guide the bird to the delivery or pick-up point. The laser, Spectra Physics Model 132, is mounted on a pivoting stand and equipped with a motor driven chopper and simple open sights for aiming. (Photo 12) A spec sheet is included in the appendix.

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As an aid to aiming the guidance laser, a telescopic sight has been mounted on a Spectra-Physic model 132 laser. Properly adjusted, the scope provides a line of sight parallel with the laser beam and 2 1/4" above the beam. The laser may be aimed with the scope crosshairs appearing 2 1/4" above the point at which the laser spot is to appear. (Photo 13 shows the scope-equipped laser mounted on a camera tripod.)

A laser requires the nominal 115 Volt 60 Cycle alternating current (ordinary U.S. house current). Where only 240 Volt house current is available, a step down transformer may be used.

For use where neither 120 nor 240 Volt AC power is available at the launch site it is possible to use an inverter to convert 12 Volt battery power to 120 Volts, 60 Hz power. A Honda motorcycle battery, model 12N9-3A, and a Terado inverter, model 50-170, is suitable for this purpose. (Photo 14) (Specs in appendix) It is reasonable to expect that a 12 Volt motorcycle battery of 10 ampere hour rating will

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operate the laser via the inverter for at least one hour continuously.

E. Recall Lamp

This is a conventional "high-intensity" miniature lamp. Ordinarily such lamps employ a 12 Volt bulb and are equipped with a built-in transformer for 120 Volt AC operation. Because timing of the recall is critical, the lamp is equipped with an easy working external foot operated switch. If 115 Volt 60 Cycle alternating current is not available the recall lamp can be used with a step down transformer or with the inverter mentioned in section D, above.

It has been found that the high intensity lamp, used as a recall signalling device, is overly bright if directed outward toward the returning bird under dark twilight conditions. The light may be directed downward to avoid blinding the bird. If the launch cage is visible to the returning bird, the lamp may be placed on top of the cage aimed so that it illuminates the interior of the cage through an opening in the cage top. (Photo 15)

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IV. Hypothetical Example of System in Use

It may be helpful in understanding the procedures of care and working of the birds to consider them in terms of an imaginary mission program. Following is a description of a hypothetical mission. The principal emphasis of the description is on care and handling of the birds.

An overseas mission is planned requiring the placement of a device at approximately a certain date. Following initial placement, the device is to be retrieved and replaced at intervals ranging from two to four weeks. Actual mission flights are planned for either dawn or dusk as opportunity arises.

A team of two birds is to be flown overseas. Information concerning working weight and any idiosyncracies is known by the handler. Air travel time, including stop-overs, will total 36 hours. Arrangements have been made to store the birds and equipment at a secure "base station" in the general area of the mission site. Air travel is to be by aircraft over which mission personnel has control, that is,

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not by commercial air line.

Birds are to travel in shipping-living cages approximately the dimensions of a two foot cube. These cages can, when necessary, be taken apart and the parts folded. The equipment and supplies check list is carefully gone over (section VI) and all items are packed for shipping.

Ten days before the first planned mission the birds, supplies, and equipment are loaded aboard a plane for the first leg of the journey. During travel the birds are hand fed crow salad three times a day because eating tends to reduce possible traumatic effects of travel experience. Feeding times are separated in time as much as reasonably possible, four or five hours apart, for example. At each feeding, a bird is given all the food he will quickly consume. If the bird does not consume his alloted daily ration at the end of the third hand feeding session, the remainder of the food is placed in the feed cup.

The trip to an overseas air field requires three days, including one stop-over enroute, during which the normal

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feeding schedule is maintained. From the air field the birds are to be taken by a small car to a secure base station at a distance requiring about three hours of driving. The shipping cages are too large to fit into the car, so the birds are transferred to the smaller cages. The shipping cages are folded so that they may be carried in the trunk of the car. Other equipment, packed in suitcases, is also carried in the car.

Upon arrival at the base station the birds are transferred again to the larger cages.

The fourth day is the first at the base station. The birds are weighed and found not to have lost weight in transit. Two attempts, spaced about eight hours apart, are made to work the birds at short range indoors. They perform poorly at the first session, better at the second as appetite returns. At the end of the day the birds are hand fed, each from his allotment of 50 grams of crow salad, part of which has been earned in the exercise sessions. One bird stops eating before he has consumed all of the allotment and is fed no

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more for the day.

On the fifth day both birds are more active and are each given several exercise sessions in the course of the day. These sessions are held indoors, some at the maximum possible ranges down a hallway. A laser is used in guidance. Each bird works sufficiently to have received about 50 grams of crow salad as rewards and neither is given additional food at the end of the day.

On the sixth day each bird again works well indoors and, in the course of the exercise sessions conducted periodically throughout the day, earns the allotment of 50 grams.

On the seventh day it is found possible to arrange for outdoor "simulated mission" flights at dawn and at dusk. The birds are tried in the morning session first tethered at short range because their handler does not wish to risk danger of even temporary straying of a bird. The birds do not seem eager to work, probably because of fairly low drive, and so range is not extended and the outdoor practice session is

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ended. The birds are given only a few indoor exercise sessions in the course of the day, so as to allow drive to increase. At a dusk session outdoors the birds are more eager to fly. Following a few short range tethered flights, range is extended to mission distance and a few successful untethered flights are made. Only four longer range flights (two correct placements and two retrievals) are permitted because, again, of fear of straying by a partially sated bird. Evening weighing of the birds indicates a weight loss of about 15 grams for each bird. The loss is not considered alarming, and the birds are fed only the remainder of their allotment.

An actual mission flight has now been scheduled for a site a few hours drive from the base station. Placement of a package on a target ledge is planned for 6:00 pm of the tenth day. Launch is to be from the window of an apartment located about 100 feet from a target ledge. Only one bird is to be taken to the apartment a few hours before the attempt is made.

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On the eighth day the handler decides to make a choice between the two birds at an evening outdoor test session. The birds are kept idle through the day, not exercised because he wishes to build up drive for the evening test. At dusk, both birds are tested at mission range. Both perform properly, but one shows less hesitation in placing a package on a target ledge, setting it down without showing any tendency to pick up again and responding quickly to the recall lamp signal. This bird is first choice for the mission, but both will be made ready.

It is now approximately 48 hours from the scheduled mission flight time. Past feeding has maintained the birds at near optimum weight. Each is now found to be only about 10 grams under the recommended optimum holding and training weight. Each is then fed the remainder of his day's 50 gram ration. All litter and any other substances that a hungry bird might ingest are removed from the cages. Only drinking water remains.

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Twenty four hours later (T minus 24) each bird is given a short indoor working session, but allowed to earn no more than 10 grams of food.

At opportune times, necessary equipment, e.g., laser, recall lamp, etc., is moved in suitcases to the launch apartment. Late evening, after dark, is deemed the most secure time to move the chosen bird to the apartment. The bird is transferred to one of the launch cages. His living cage is folded and, because it is too large to fit a suitcase, is wrapped as a package. Bird, cage package, and a "black box" cage are taken in a small car for the trip to the launch site. Shortly before arrival the bird is transferred to the "black box". This box, 18" x 7 1/2" x 13 1/2" is ventilated by baffled, light-tight openings. Because of complete darkness in the box, a bird carried in it makes a little or no noise. The launch cage is folded and placed in a suitcase.

Bird, suitcase, and wrapped living cage are carried into the apartment. The cages are unwrapped, assembled, and the bird is transferred to the living cage.

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As time T approaches, equipment is set up. It is found convenient to place the laser at one window and the launch cage and recall lamp at another. As dusk begins to fall the bird is moved from the living cage to the launch cage. Unfortunately, a heavy rainfall commences and lasts through the dusk period. A light rain or mist might have reduced the risk of detection and yet permitted the flight to have been attempted, but it now must be postponed.

It is decided to "hold" until dawn at which time another attempt at delivery may be possible. This will mean a delay of 12 hours. The handler estimates that at the "holding" rate of feeding of 30 grams per 24 hours, he should feed the bird 15 grams of crow salad. Lacking a scale he guesses the amount accurately enough. He has left word at the base station to feed the reserve bird at the same rate.

At the first signs of morning light, equipment is again placed and checked and the bird is again transferred to the launch cage. As soon as the target becomes clearly

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visible the windows are opened and the laser is sighted at the ledge and turned on very briefly to check the aim.

Rather than risk a package on the first flight, the handler signals for the laser to be turned on and releases the bird but does not present him with the package. The bird flies to the target, the laser is switched off, the recall lamp is turned on and immediately extinguished as the bird enters the cage. The bird is rewarded at the same time. (Had the bird seemed "spooky" of the target ledge, one or two more no-load runs might have been made if it seemed safe to allow them.)

For the final flight, the package is held at the cage opening as the door is opened. The bird grasps it, flies to the target ledge, and is recalled as soon as the package is put down. Reward follows the return, and if package placement is considered acceptable the mission is "wrapped up". (If the positioning of the package is critical and it is not acceptably placed, it may be necessary to send the bird out to recover it and then to try again. If the bird cannot be

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faulted for an improper placement, for example, if he accidentally moves it with his foot on take-off to return to the cage, there is no question but that he should be rewarded. If placement is faulty because of failure to make the placement in accordance with previous training, it may still be necessary to use the recall signal, which is rewarding in itself, even though this is poor training procedure. In an actual mission avoiding temporary loss of the bird is more important than slight possible deterioration of behavior.)

The bird has successfully accomplished a placement and it is expected that the package will remain in its place for some time. Both birds have lost weight because of food deprivation in preparation for the flight. The mission bird is hand fed immediately as much as he will accept. A message to the base station informs the station that the back-up bird is to be similarly fed.

The mission bird is returned to the base station as soon as it is practical to do so. A two day rest and "feed-up" restores both birds to normal weight.

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At the base station, the regular feeding and exercise program is restored. Although it is hoped that recovery and replacement of the package can be programmed as a regular operation for every three weeks, it is realized that emergencies may arise requiring, on short notice, a retrieval of a package. It is not possible to keep a bird constantly ready to go, but the handler arranges a schedule which feeds each bird lightly on a different alternate day. For example, one bird is allowed only 35 grams, the other given 65 grams on a particular day. The next day the feed allotment is reversed. Thus there is always one bird kept at a fairly high drive.

If an emergency should arise, both birds are immediately deprived of food. As one bird is already on a mild deprivation schedule, he should be ready to go to work in 24 to 30 hours following the last feeding.

In an emergency, the readiness of a bird must be judged at the time by the handler. He has deprived both birds but even though one may theoretically be more hungry than

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the other, he must make his choice of the birds in terms of apparent eagerness to work and upon his knowledge of their past records. In an emergency situation in which bird eagerness cannot readily be judged, it is more likely that a "doubtful" bird will make a retrieval rather than a placement. Placement is the more difficult behavior.

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V. Check List of Information Needed from Field for Operational Planning

A. Photograph and description of target

1. Height of target from ground
2. Distance of target from launch point
3. Horizontal angle of target from launch point
4. Knowledge of depth of target ledge
5. Scale of photograph
6. Any peculiarities of target

B. Description of launch point

1. Height of launch point from ground
2. Available power
3. Indoor or outdoor release
4. Size and configuration of launch opening, i.e., window, back of truck, etc.
5. Any peculiarities of the launch point such as drapes over windows, grill work, etc.

C. Operational site environment

1. Climate
2. Urban or rural

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3. Obstacles between launch point and target, i.e., trees, window grills, window shutters, phone and electric wires
4. Time of day for operation
5. Any local wind peculiarities in area covered by bird
6. Dawn or dusk
7. Noise level and peculiar noises
8. Any possible disturbing influences - human activity - dogs, cats, other birds, etc.

D. Type and length of travel required

E. Legal restrictions or obstacles in international transport of birds

F. Overseas storage and maintenance

G. Facilities available

1. Indoor exercise
2. Outdoor exercise
3. Local availability of food items, litter, etc., for birds

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VI. Equipment and Supplies Check List

1. Trained birds - 2 each
2. Folding living-shipping cages - 2 each
3. Folding launch cages - 2 each
4. Laser with open or telescopic sights - 2 each
5. Laser mount with chopper and base - 1 each
6. Power Supply containing Terado inverter, storage battery, and battery charger, - 1 each
7. Step-down transformer (230 v. to 115 v.) - 1 each
8. Recall lamp with foot switch - 1 each
9. Map case (black box) - 1 each
10. Scale with calibration weights - 1 each
11. Fresh crow salad in thermos jug
12. Freeze-dry crow salad
13. Sulmet or other sulfa drug
14. Silver nitrate
15. Vitamycin
16. Bone meal
17. Dummy training packages
18. Food grinder - 1 each

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19. Emergency recall signal, audible - 2 each

20. Cage litter (commercial Kitty litter)

21. Spray bottle for water - 1 each

22. Binoculars or other visual aids

23. Tethering equipment

    reel with line

    snap swivels

    leg bands

24. Spare parts

    Laser fuse (Buss MDL 1/2 amp, Fusetron fuse) Terado

    Inverter fuse (Buss AGC-25 or Littelfuse 3AG-25)

    Bulbs, recall lamp (size 93-12 volt)

    10' extension cord with 3-way outlet

    3 wire adapter for laser

    Small Phillips screwdriver

    Long-nose pliers

    Roll electrician's tape

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INVERTER

SPECIFICATIONS

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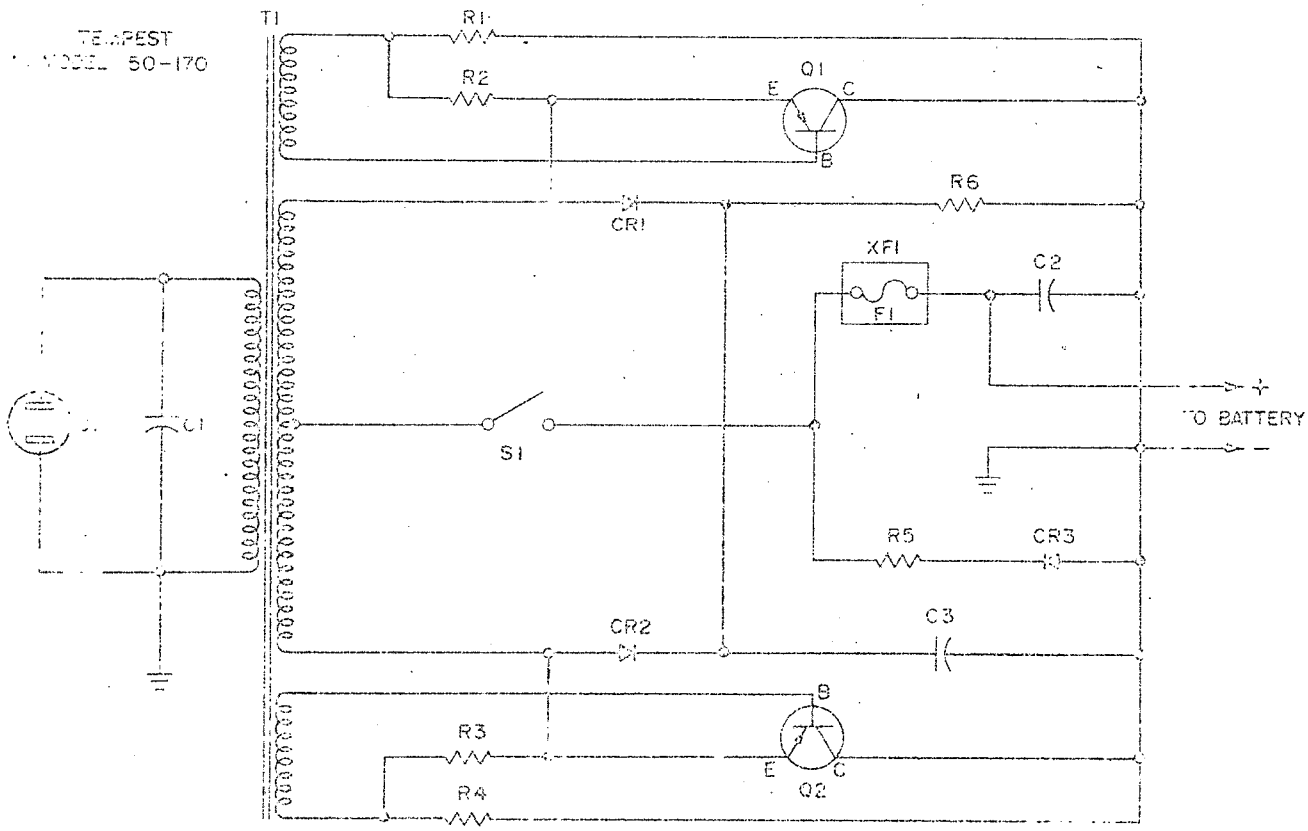
TEMPEST MODEL 50-1

OPERATING INSTRUCTIONS



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OPERATING INSTRUCTIONS
MODEL 50-170 TEMPEST

INPUT VOLTAGE - 12 VOLTS D.C. CAR VOLTAGE REGULATOR MUST BE SET NO HIGHER THAN 13.8 VOLTS WHEN ENGINE IS WARM
OUTPUT VOLTAGE - 117 V.A.C.
CAPACITY - 125 WATTS CONTINUOUS
150 WATTS INTERMITTENT

1. CAUTION: MAINTAIN AT ALL TIMES, AT LEAST A 30 TO 40 WATT LOAD ON THIS INVERTER. WITHOUT THIS LOAD THE PEAK COLLECTOR TO EMITTER VOLTAGE WILL RISE AND CAUSE TRANSISTOR FAILURE. THIS INVERTER IS NOT DESIGNED FOR CONTINUOUS OPERATION. A PERIOD OF FIVE (5) HOURS USAGE SHOULD NEVER BE EXCEEDED IN ANY CASE. COOLING OF THE POWER TRANSISTORS IS VERY CRITICAL AFTER THIS TIME IS REACHED.
2. FUSING - USE ONLY 25 AMPERE FUSES. RECOMMENDED TYPES: BUSSMAN AGC25 & LITTLEFUSE 3AG-25. NEVER SLUG FUSES. THIS COULD CAUSE COMPLETE BURN-OUT OF POWER TRANSISTORS AND TRANSFORMERS.
3. FOR FACTORY SERVICE - ADVISE OUR FACTORY SERVICE DEPARTMENT THAT THE UNIT IS BEING RETURNED, ALONG WITH AN EXPLANATION OF PROBLEMS. FLOAT PACK OR CAREFULLY CUSHION UNIT TO AVOID DAMAGE. ALSO EXAMINE WHEN RECEIVED AND MAKE CLAIM IF NEEDED.
4. SHIPPING - VIA PREPAID EXPRESS OR TRUCK - DO NOT SHIP PARCELPOST - WARRANTY WILL BE VOID IN ALL CASES IF THESE INSTRUCTIONS ARE NOT FOLLOWED.
5. CAUTION - YOU ARE RESPONSIBLE FOR DAMAGE TO YOUR UNIT IF RETURNED IMPROPERLY PACKED ****SAVE PACKING MATERIAL UNIT IS RECEIVED IN****
6. WARRANTY - THE TEMPEST INVERTER IS GUARANTEED AGAINST DEFECTIVE WORKMANSHIP AND MATERIAL FOR A PERIOD OF 90 DAYS. WE RESERVE THE RIGHT TO REVOKE THIS GUARANTEE IF IN OUR OPINION THE CONDITIONS AND INSTRUCTIONS HAVE NOT BEEN FOLLOWED. A NOMINAL SERVICE CHARGE FOR PARTS AND LABOR WILL BE MADE ON ALL UNITS OUT OF WARRANTY.

INSTALLATION OF INVERTER

1. CAUTION: DO NOT INSTALL INVERTER IN MOTOR COMPARTMENT AS EXCESS HEAT CAN CAUSE TRANSISTORS TO FAIL. ALSO THE WEATHERPROOFING UNDER THE HOOD OF VEHICLE IS INSUFFICIENT. UNIT SHOULD BE INSTALLED IN DRY AREA.
2. KEEP RADIOS AWAY FROM INVERTER AND ITS WIRING, TO REDUCE NOISE PICK-UP. REVERSE AC PLUG IF NOISE IS HEARD WHEN OPERATING RADIOS. THIS INVERTER NOT RECOMMENDED FOR TAPE RECORDERS.
3. CAUTION: THE INVERTER INPUT LEADS MUST BE CONNECTED TO THE PROPER POLARITY TERMINALS TO INSURE PROPER OPERATION. THIS UNIT IS EQUIPPED WITH A POLARITY SENSING DEVICE THAT WILL BURN OUT IF BATTERY CABLES ARE CONNECTED UP IN REVERSE OF ABOVE. SERIOUS DAMAGE TO TRANSISTORS CAN ALSO RESULT IN THE CASE OF REVERSE POLARITY.
4. INVERTER IS DESIGNED FOR NEGATIVE GROUND VEHICLES. CABLES SHOULD BE CONNECTED RED TO POSITIVE - BLACK TO NEGATIVE. CAUTION - IF THE VEHICLE A POSITIVE GROUNDED SYSTEM, COMPLETE INVERTER WILL HAVE TO BE INSULATED FROM VEHICLE BODY.
DO NOT OPERATE REFRIGERATORS OR COMPRESSORS. STARTING CURRENT WILL IMMEDIATELY DESTROY TRANSISTORS. WARRANTY VOID

OPERATION OF INVERTER

1. THIS IS A TRANSISTORIZED POWER INVERTER USING 2 TRANSISTORS ON MODEL 50-170. IT IS DESIGNED TO GIVE PEAK EFFICIENCY INVERTING 12 VOLTS DIRECT CURRENT TO 110 VOLTS AC - 60 CYCLES.
2. THIS INVERTER DOES NOT HAVE EXACT 60 CYCLE CONTROL FEATURE BUILT IN. THE FREQUENCY OF UNIT IS DEPENDENT ON THE INPUT VOLTAGE AND THE LOAD ON THE 110 VOLT SIDE.
3. THIS INVERTER WILL OPERATE MANY 110 VOLT APPLIANCES. THESE INVERTERS ARE NOT RECOMMENDED FOR FREQUENCY SENSITIVE EQUIPMENT.
4. CAUTION: OPERATION OF FLUORESCENT LIGHTS - FIXTURE MUST BE POWER CORRECTED. DISREGARD WATT RATING OF TUBE OR TUBES, STARTING CURRENT MUST NOT EXCEED 75% CAPACITY OF INVERTER. MEASURE STARTING CURRENT WITH A WATT METER BEFORE ATTEMPTING TO USE WITH INVERTER.
5. CAUTION: DO NOT OVERLOAD INVERTER WITH APPLIANCES SUCH AS TOASTERS, ELECTRIC FRYING PANS, ELECTRIC COFFEE MAKERS, LARGE MOTORS, HEAVY POWER TOOLS. ALWAYS INSPECT NAMEPLATE ON APPLIANCE FOR WATTAGE BEFORE USING, OR MEASURE WITH A WATT METER. LOADS IN EXCESS OF RATINGS ON INVERTER WILL ACT AS A SHORT CIRCUIT AND CAUSE TRANSISTOR FAILURE.

PARTS LIST FOR MODEL 50-170

SYMBOL	PART NAME	PART NO.
C-1	CONDENSER .1 MFD - 400 VOLT PAPER	1025
C-2	CONDENSER 4000 MFD - 50 VOLT ELECT.	1365
C-3	CONDENSER 500 MFD - 50 VOLT ELECT.	1031
CR-1	RECTIFIER 1.0 AMP - 50 PIV	1204
CR-2	RECTIFIER 1.0 AMP - 50 PIV	1204
CR-3	RECTIFIER 1.0 AMP - 50 PIV	1204
F-1	FUSE - 25 AMPERE	1040
XF-1	FUSEHOLDER, HKP	1039
J-1	RECEPTACLE, ROUND 2 WIRE TYPE	1159
Q-1	TRANSISTOR, POWER - TYPE 2N2152	1352
Q-2	TRANSISTOR, POWER - TYPE 2N2152	1352
	(NOTE: THE ABOVE TRANSISTORS ARE SELECTED UNITS AT THE FACTORY - THE ABOVE TYPES MAY BE SUBSTITUTED IN CASE OF EMERGENCY)	
R-1	RESISTOR, 100 OHM - 5 WATT	1328
R-2	RESISTOR, 1.5 OHM - 5 WATT	1327
R-3	RESISTOR, 1.5 OHM - 5 WATT	1327
R-4	RESISTOR, 100 OHM - 5 WATT	1328
R-5	RESISTOR, .47 OHM - 2 WATT	1227
R-6	RESISTOR, 150 OHM - 5 WATT	1329
S-1	SWITCH, SPST	1133
T-1	TRANSFORMER, POWER	1019-3
	RED LEAD BATTERY CABLE, #14 WIRE - 6 FT.	1186
	BLACK LEAD BATTERY CABLE #14 WIRE - 6 FT.	1187

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LASER

SPECIFICATIONS

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1.0 Model 132 Specifications

Output

Power:	1.0 milliwatt minimum
Wavelength:	632.8 nm (visible red)
Transverse Mode:	TEMoo
Longitudinal Mode Spacing:	550 MHz
Beam Diameter:	Approximately 0.8 mm at $1/e^2$ points
Beam Divergence:	Approximately 1.0 milliradian at $1/e^2$ points
Polarization, 132:	Unpolarized
Polarization, 132-01:	Vertically Polarized (cross component less than 3%)

Stability

Intermode Amplitude Noise (1-100 kHz):	Less than 0.3% rms.
Amplitude Ripple (120 Hz over voltage range 105 vac to 125 vac)	Less than 0.5%
Warmup Time:	Greater than 0.7 mw at turnon. Greater than 1 mw three minutes after turnon.

Environmental

Operating Temperature:	0 to 40°C
Storage Temperature:	-20°C to 65°C
Altitude:	10,000 feet maximum

Power

Voltage:	105V-125V rms
Frequency:	60-400 Hz
Volt-amps:	35 volt-amps, max
Cable Length:	6 feet

Mechanical

Weight:	7.5 lbs, (3.4 Kg)
Dimensions:	15.5 x 5.6 x 3.9 inches
High Voltage Protection:	An interlock is provided on the bottom coverplate to disable the high voltage supply whenever the plate is removed. 1"-32 thread is provided to connect accessory telescopes.

Options

01	Linear Polarization (cross component less than 3%)
02	190-250V rms 50-400 Hz 35 volt-amps, max 6 feet of power cord

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2.0 Introduction

The Spectra-Physics Model 132 CW Gas Laser provides the high level of performance and reliability associated with Spectra-Physics leadership in the gas laser field. Quality workmanship and performance features such as conservative operating specifications, guaranteed stability, and self-starting are standard. A compact, light-weight package and simplicity of operation make the 132 Lablite a pleasure to use.

Heart of the Model 132 is a new internal mirror plasma tube with long-life cold cathode. Spectra-Physics technical leadership in HeNe plasma tube physics has been fully incorporated into the 132 tube. Improvements in cathode design, plasma tube sealing, and dielectric coatings result in extended lifetime and improved amplitude stability.

The output of the Model 132 behaves as unpolarized light in most experiments. However each axial mode of the 132 internal mirror plasma tube is actually polarized perpendicular to adjacent modes. For applications requiring a polarized light, Option 01 provides a cross component that is less than 3%. This degree of polarization is sufficient to provide the benefits of polarized light in most applications.

3.0 Operation

WARNING

IF THIS UNIT IS DROPPED OR OTHERWISE DAMAGED, IT SHOULD BE CHECKED BY A QUALIFIED TECHNICIAN BEFORE CONNECTING TO A POWER SOURCE.

1. If the laser is a European model, ("220-240" on serial tag) check that power is disconnected. Then remove six screws to release bottom panel, and adjust transformer input tap for the closest available line voltage. The transformer is wired for 240v operation between transformer taps 1 and 3 at the factory. Taps 1 and 2 connect the laser for 220v operation.

   Note

   It is important that the transformer be connected for the correct input voltage. If low voltage is connected to the 240v tap the laser may not start. Connection of high voltage to the 220v tap may result in decreased plasma tube life. BE SURE TO REPLACE BOTTOM COVER BEFORE APPLYING POWER.

2. Plug into appropriate power source: 117 volt, 60 Hz to 400 Hz for U.S. models; 220 Volt or 240 Volt, 50 Hz to 400 Hz for European model.

3. Place the power switch (next to line cord) at "on".

4. The laser should lase within 30 seconds. If not, refer to Section 4.0 for troubleshooting information.

WARNING

THIS UNIT HAS HIGH VOLTAGE CIRCUITS THAT ARE EXPOSED WITH THE COVERS REMOVED.

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4.0 Troubleshooting

If there is no laser output when power is applied, the following checks will aid in locating the malfunction:

WARNING

MAINTENANCE TO THE HIGH VOLTAGE CIRCUITS IN THIS UNIT SHOULD ONLY BE ATTEMPTED BY TECHNICIANS EXPERIENCED IN HIGH VOLTAGE AND HIGH CURRENT CIRCUITS.

1. Look at the laser exit aperture (DO NOT LOOK DIRECTLY INTO THE LASER SINCE THE MODEL 132 LASER OUTPUT MAY BE HAZARDOUS TO THE EYES). Look for an indication of plasma exitation. If the plasma is lit, there will be an orange light reflecting inside the case. If the plasma is lit but there is no laser output, it can be assumed that the tube is defective. See Section 5.0 for tube-replacement instructions.

2. If there is no indication of plasma excitation in step 1, disconnect line power. Wait two minutes for high-voltage capacitors to discharge, and then remove four screws to release the top cover. Make a visual inspection of the plasma tube for breakage. Then check the fuse which is located at the rear of the upper deck.

3. If there is no evidence of malfunction on the upper deck, a defect may exist in the high-voltage supply. Remove six screws to release the lower cover. A line voltage interlock prevents application of line power to the high-voltage circuit. THIS PRECAUTION IS TAKEN BECAUSE OF THE EXTREMELY HAZARDOUS VOLTAGES AND CURRENTS IN THE HIGH-VOLTAGE CIRCUIT.

4. With line power disconnected, wait two minutes to let the high-voltage capacitors discharge, and then short out any residual capacitor charge with a well-insulated lead. Short between the "+" connection (shown in in Figure 5-1) and the "Cath" connection on the printed side of the circuit board.

5. Proceed with high-voltage circuit troubleshooting. The schematic is shown at the rear of the manual.

4.1 High Voltage Circuit

The high voltage circuit supplys the plasma tube dc excitation voltage (approximately 1300 volts). AC is transformed in T101 to 1300 RMS and the doubler circuit of diode CR 101, CR 102, and associated capacitors supply dc high voltage of 3400 volts. Ballast resistors R111 through R114 limit plasma tube current to 6 ±2 milliamperes.

Start multiplier section, CR 103, CR 104, CR 105 and C111, C112, C113 provide increased high voltage (more than 8000 volts) under a no-load condition (tube plasma not lit). This circuit becomes ineffective and high voltage drops to approximately 3400 volts as soon as the tube ignites and draws current.

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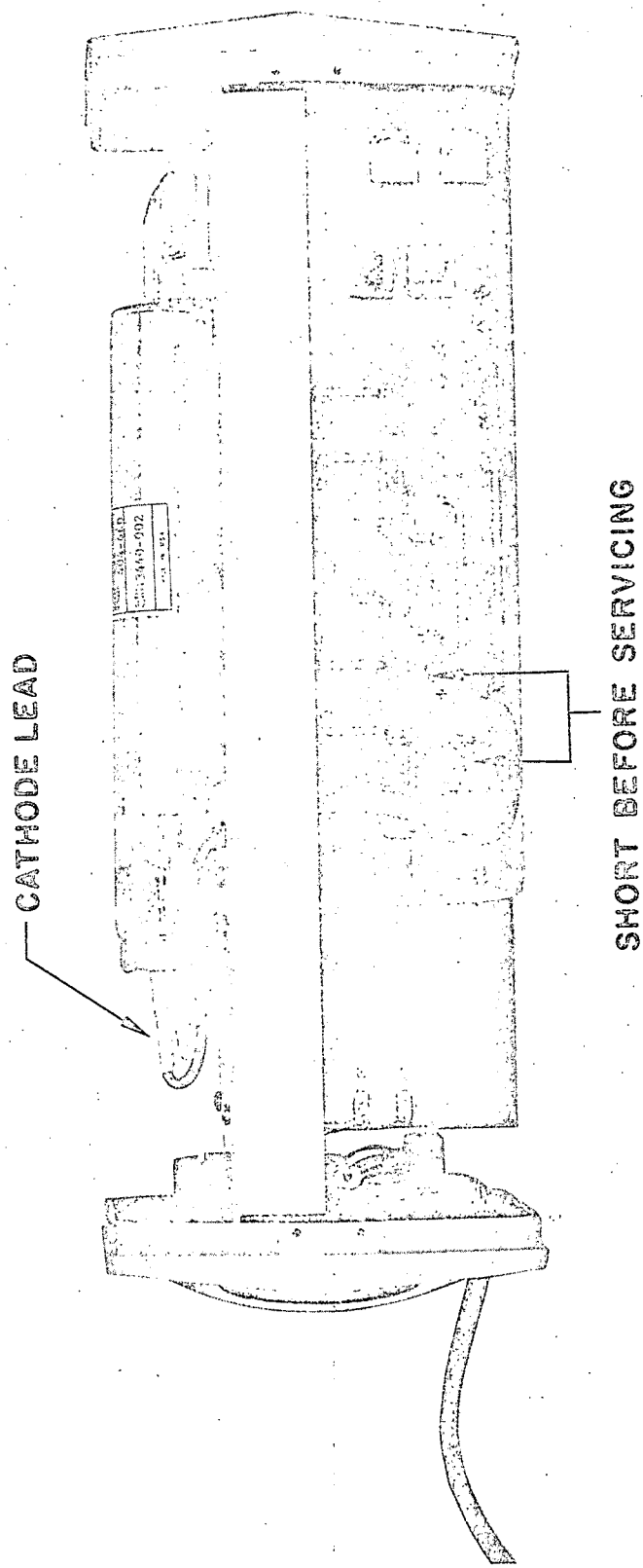

Figure 4-1 Cathode Lead

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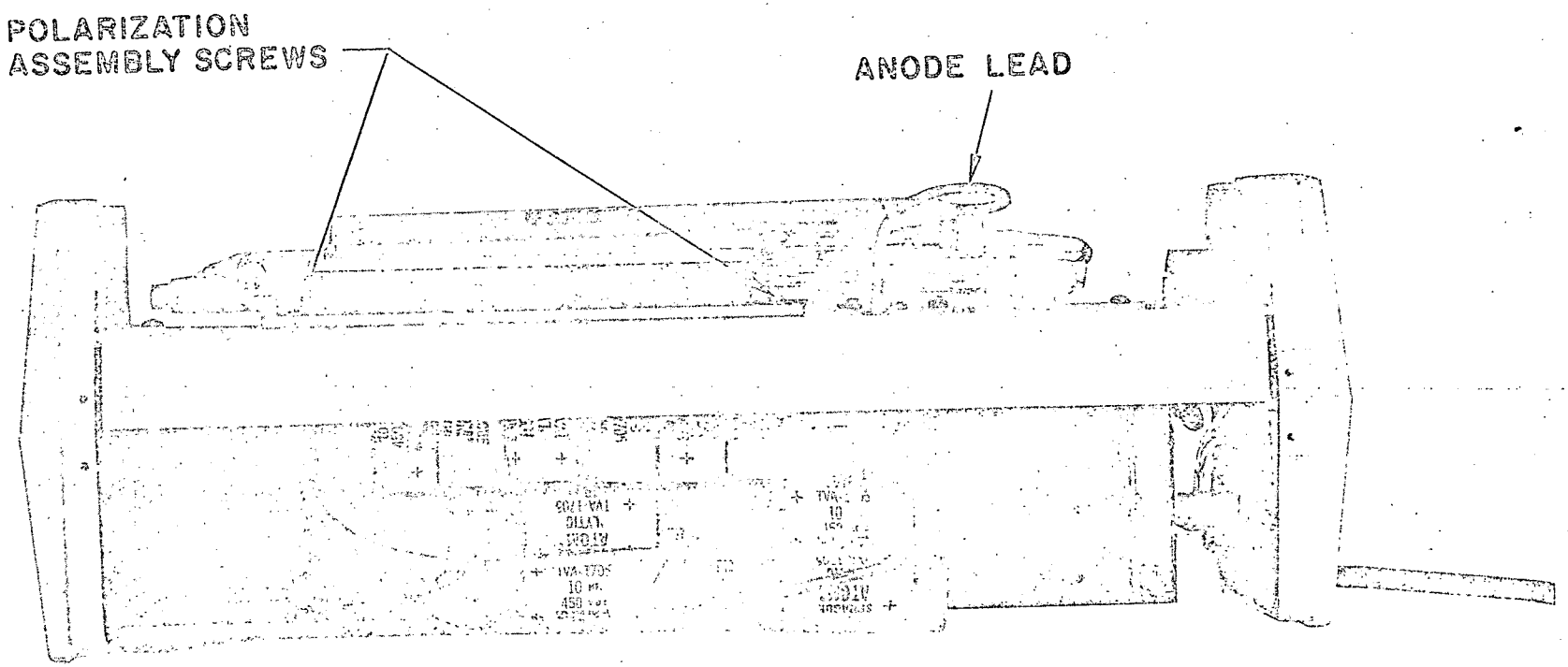

Figure 4-2 Anode Lead and Polarization Assembly

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5.0 Tube Change

5.1 Tube Removal

1. Disconnect from line power. Wait at least two minutes to allow internal capacitors to discharge.
2. Remove four screws to release top cover.
3. Remove two screws to release polarization magnet (shown in Figure 4-2). Slide this assembly clear.
4. Remove six screws to release the bottom cover. SEE WARNING BELOW BEFORE PROCEEDING.

WARNING

WITH THE BOTTOM COVER REMOVED, THE H.V. CAPACITORS SHOULD BE SHORTED OUT TO ELIMINATE THE DANGER OF A RESIDUAL H.V. CHARGE. FIRST CHECK THAT LINE POWER IS DISCONNECTED AND THEN USING A WELL-INSULATED WIRE, SHORT THE "+" CONNECTION SHOWN IN FIGURE 4-1 TO THE "CATH" CONNECTION ON THE PRINTED SIDE OF THE BOARD.

5. Unsolder the plasma-tube anode and cathode leads from the H.V. circuit board. See Figures 4-1 and 4-2 to identify the leads. Pull the leads through the top deck.
6. Use a 3/32 allen wrench to remove two plasma tube mounting screws at each end of the plasma tube. Then lift the plasma tube clear.

5.2 Tube Replacement

Replace the plasma tube and polarizing magnet in the reverse order (of Section 5.1) taking the following precautions:

1. Determine tube position by laying the polarizing magnet in place with the mounting holes lined up and positioning the plasma tube for no mechanical interference.

Note

After the tube mounting screws are tightened, do not place any bending or rotating pressures on the plasma tube.

2. Refer to Figures 4-1 and 4-2 for correct anode and cathode connections. BEAR IN MIND THAT IF THE HIGH-VOLTAGE CONNECTIONS ARE REVERSED, THE PLASMA TUBE WILL BURN OUT ALMOST IMMEDIATELY.
3. When replacing the polarizing magnet, use the slotted mounting holes to position this assembly with 1/16-inch clearance from the plasma-tube cathode.

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4. When replacing the bottom cover, note the interlock plug located at the rear of the bottom cover. When replacing this cover, guide the interlock plug into place and press firmly to engage it before fastening the bottom cover.

6.0 Field Installation of Polarization Magnet Assembly

1. Turn off line power and wait at least two minutes to allow internal capacitors to discharge.
2. Remove four screws to release top cover.
3. Lay the polarization magnet assembly in place as shown in Figure 4-2. Check that there is clearance to the tube with mounting-holes lined up. If not, loosen the tube mounting brackets to re-position the tube. Then tighten the tube in this position.
4. Using the two screws provided, fasten the polarization magnet using the slotted mounting lugs to position this assembly with 1/16-inch clearance from the cathode.

Note

A small decline in total power output (less than 20%) may be noted with the installation of the polarization assembly.

WARRANTY

All mechanical, electronic, and optical parts or assemblies, including the plasma tube are unconditionally guaranteed to be free from defects in materials or workmanship for one year after date of shipment. The simplicity and reliability of the Model 132 are such that any repairs that may be required can readily be accomplished at the users facility.

In the event that a replacement part or plasma tube is required, simply contact the nearest SPECTRA PHYSICS field office or service center, and the part will be forwarded to you in exchange for the defective item.

Units that are returned to the factory, or service center for repair will require that a $25.00 service charge and all transportation charges be paid by sender.

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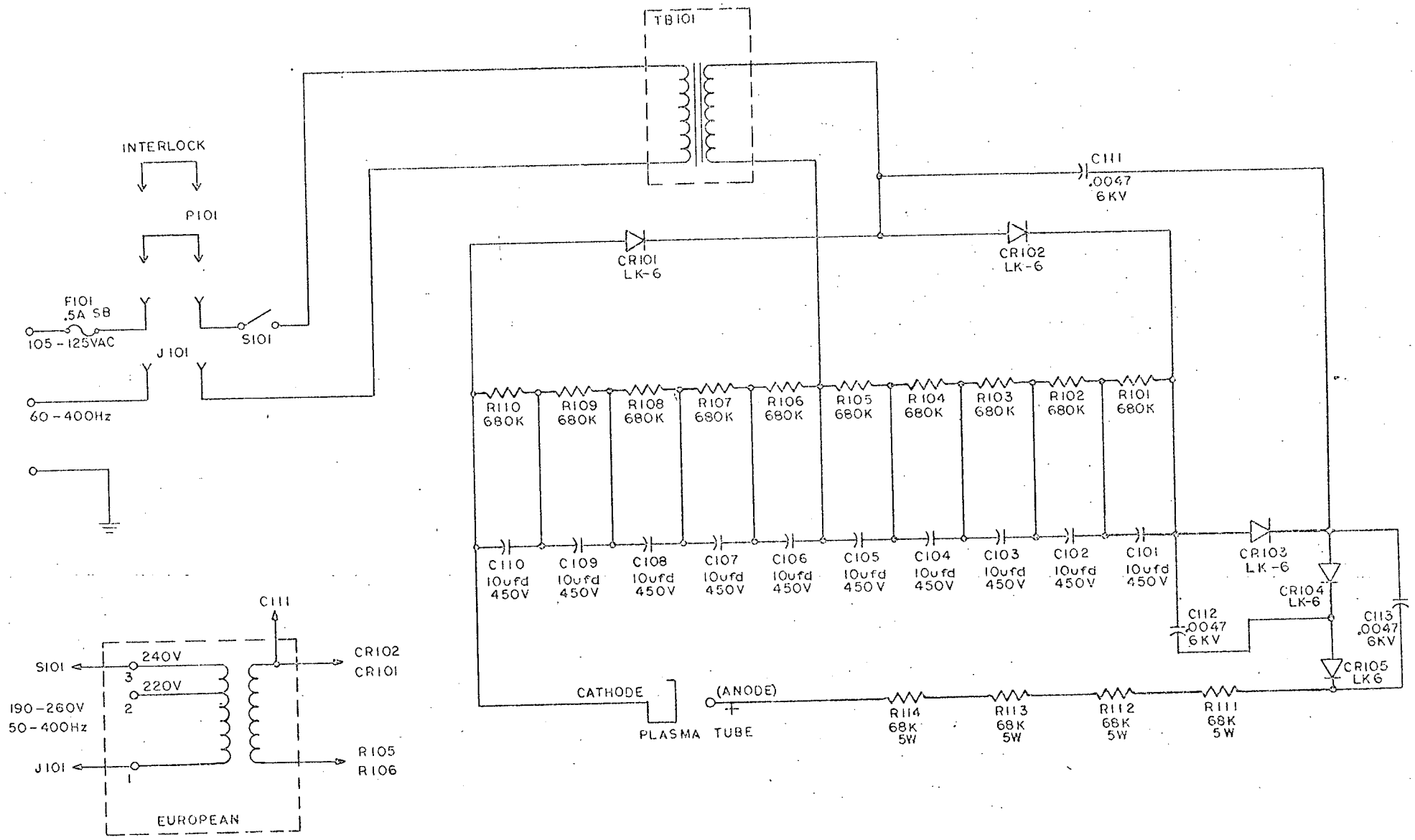

MODEL 132 LABLITE HELIUM-NEON GAS LASER SCHEMATIC DIAGRAM

PRINT NO. C404-678

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NOTE
Grip on leg; finger and wrist perch

Photo 4
Correct Way to Hold Bird

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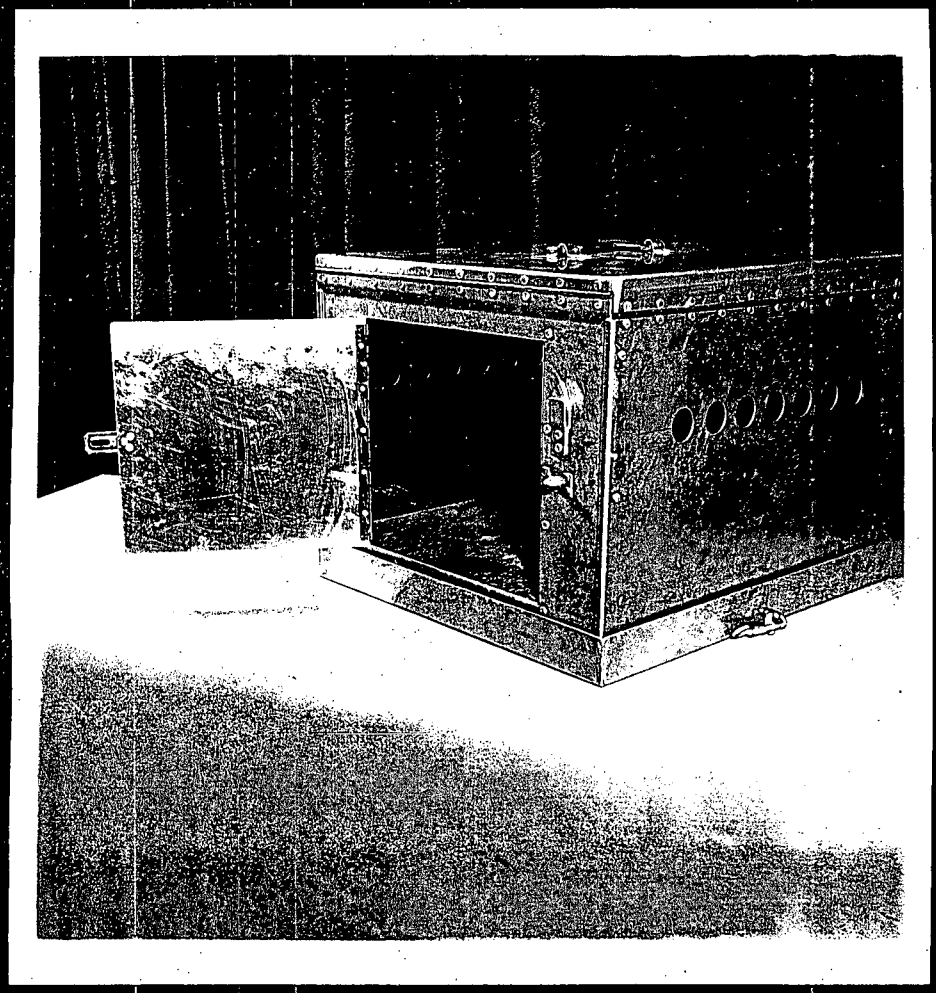

Photo 9

Launching Cage (inside)

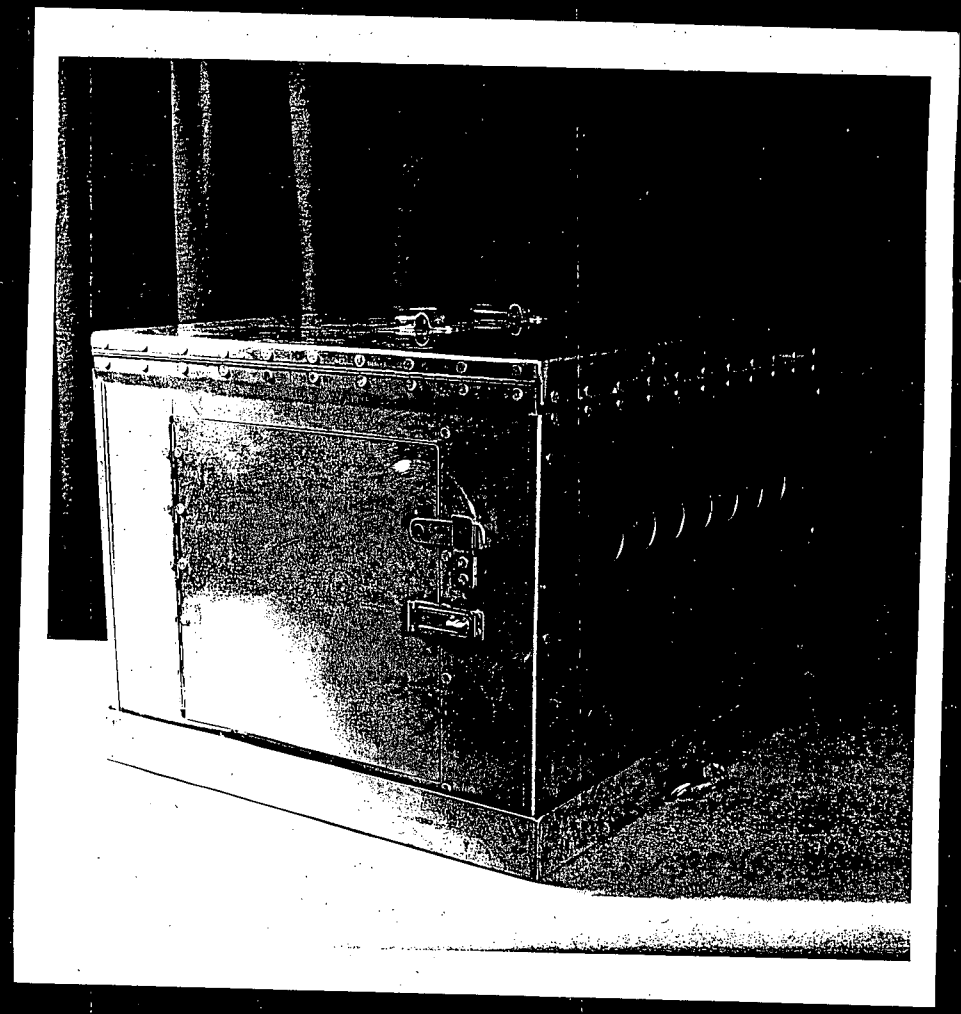

Photo 10

Launching Cage (outside)

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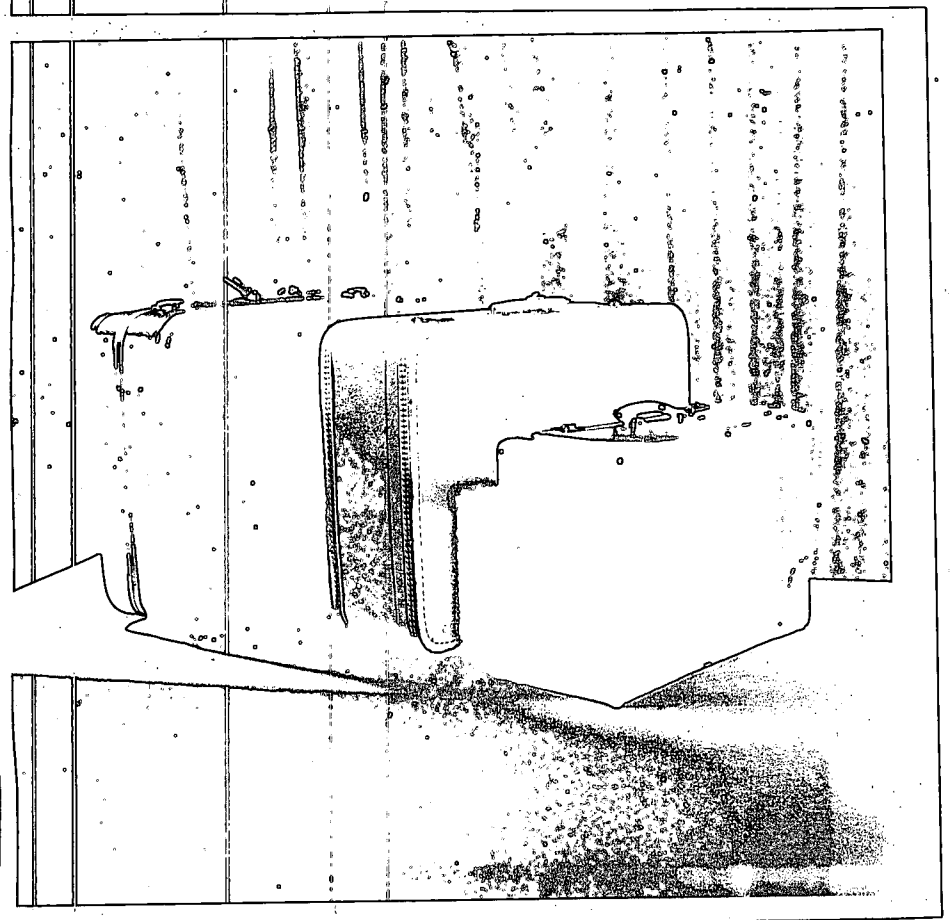

Photo 11

Rt. Black Box Lf. Carrying Cases

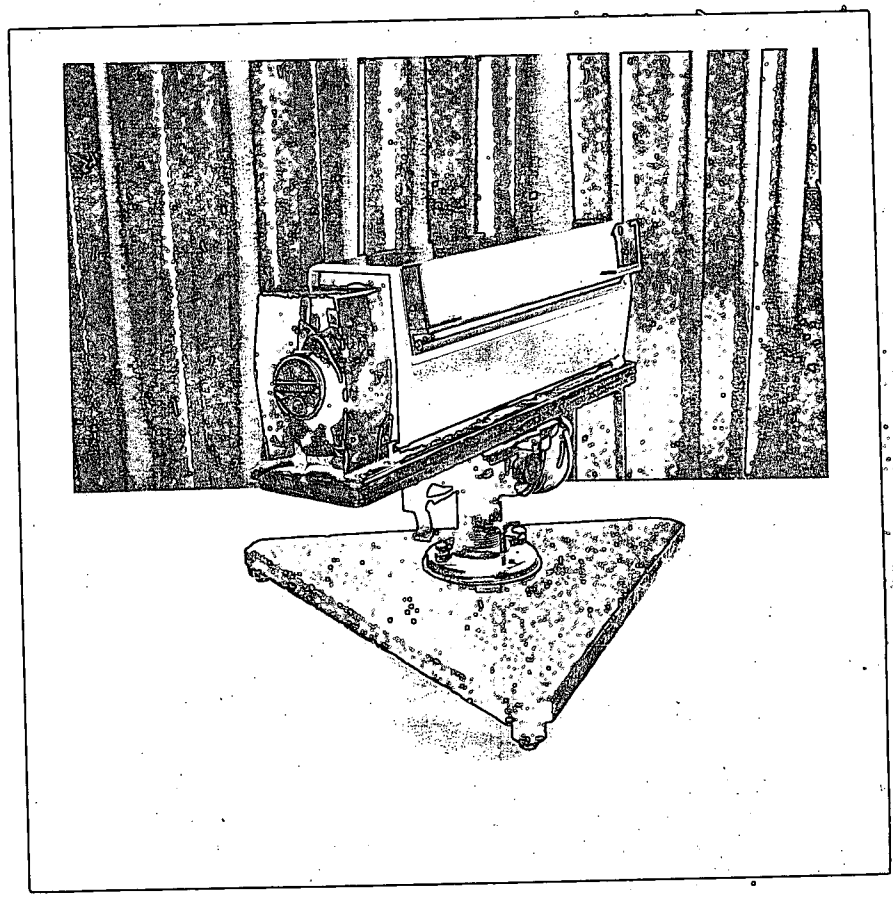

Photo 12
Laser Mounted on Pivot
and Chopper Stand

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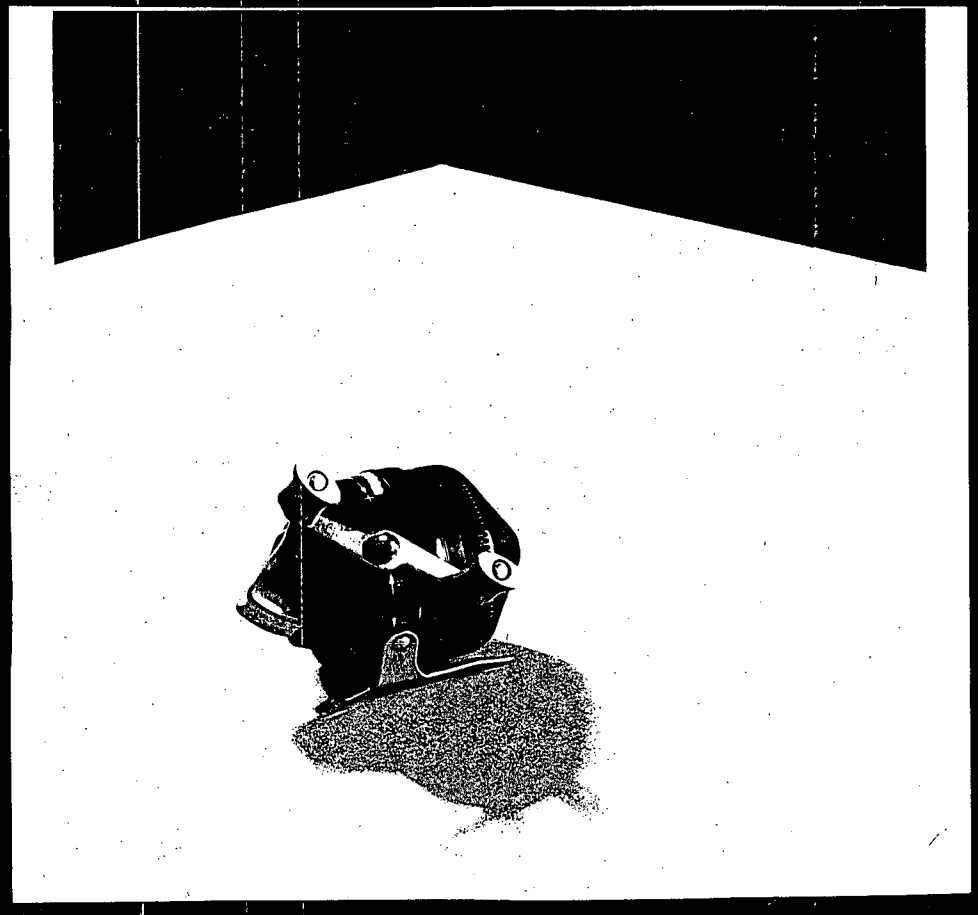

Photo 5

Spinning Reel

Photo 6

Snap Swivel Fastener

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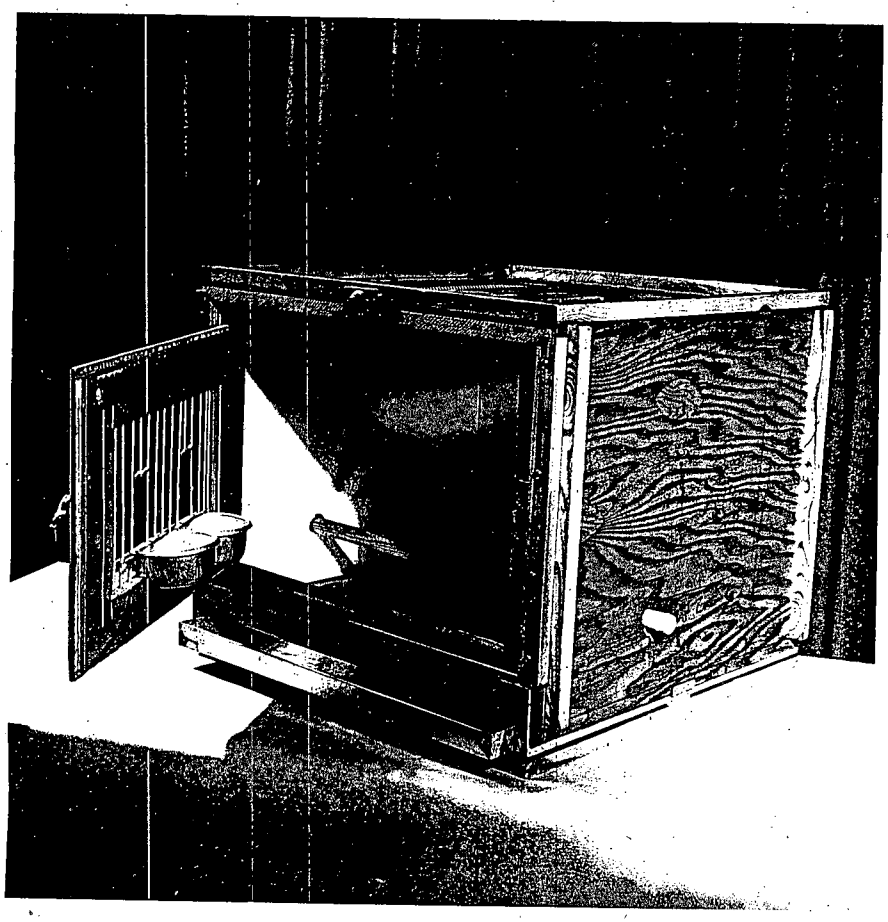

Photo 7

Shipping-living Cage (inside)

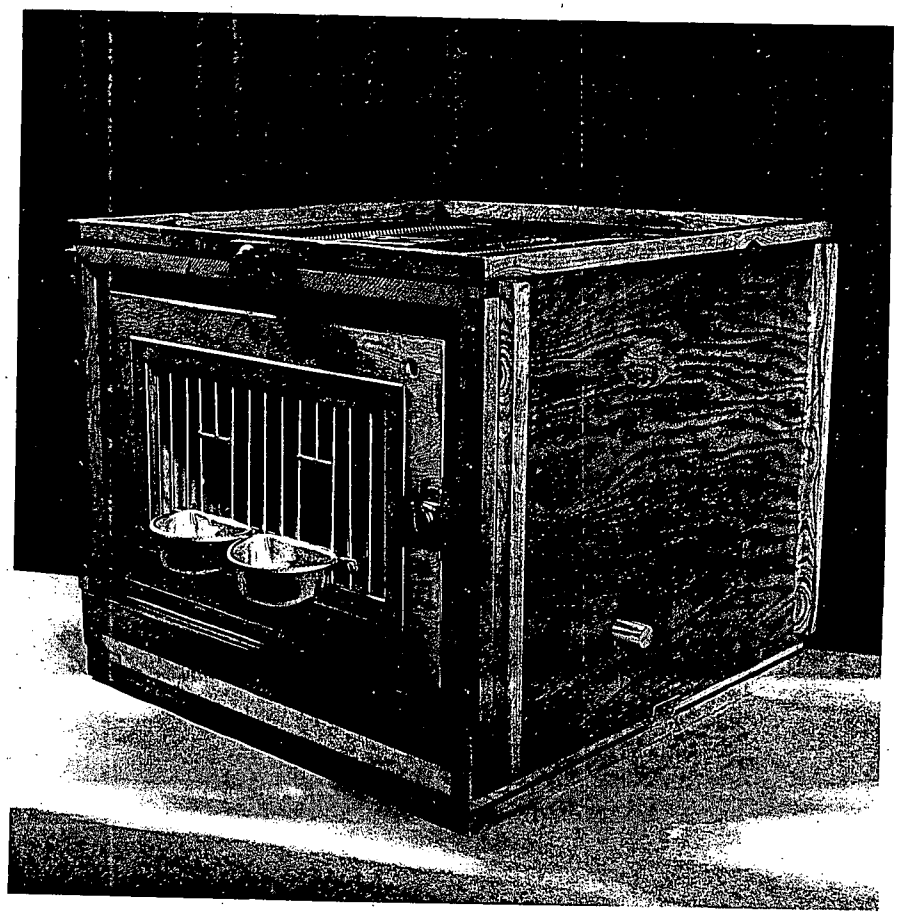

Photo 8

Shipping-Living Cage (outside)

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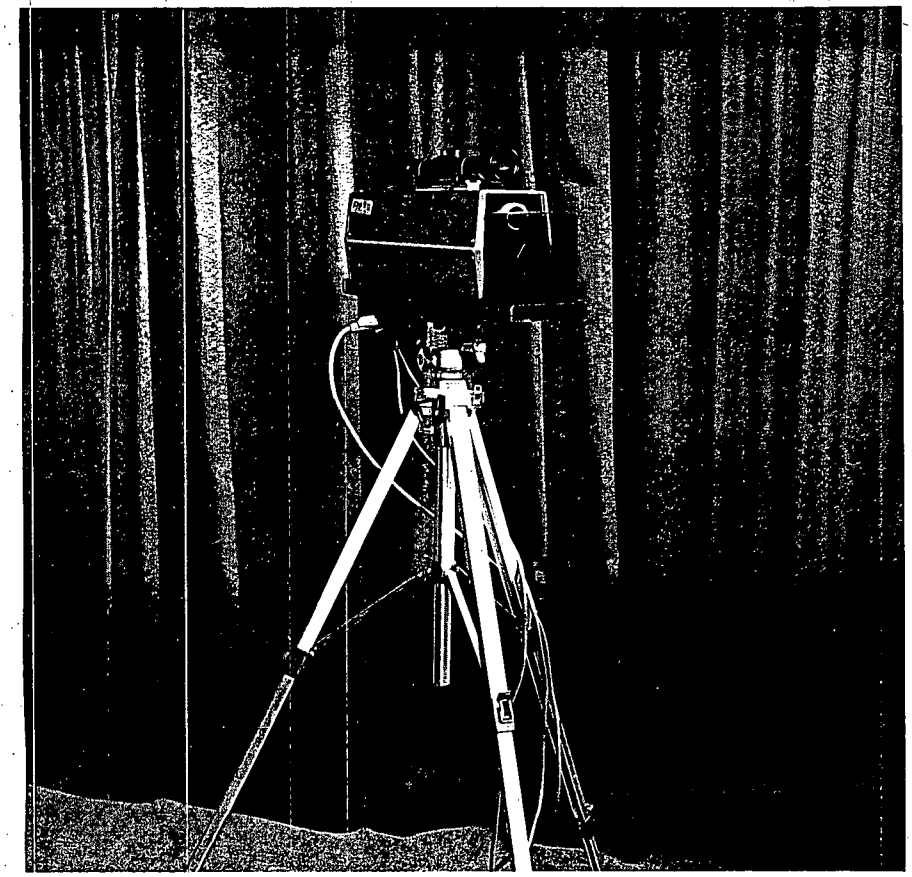

Photo 13
Laser with Telescopic Sight on Tripod

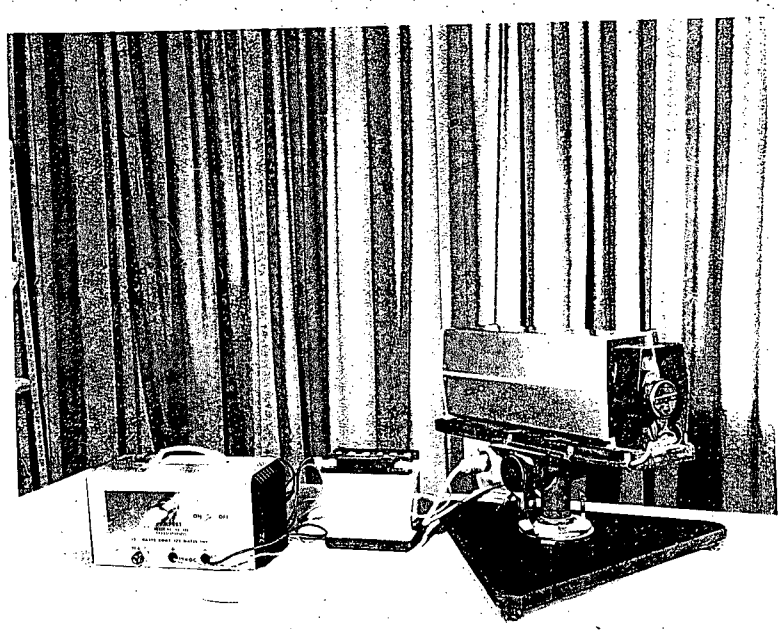

Photo 14
Laser Connected to Inverter and Battery

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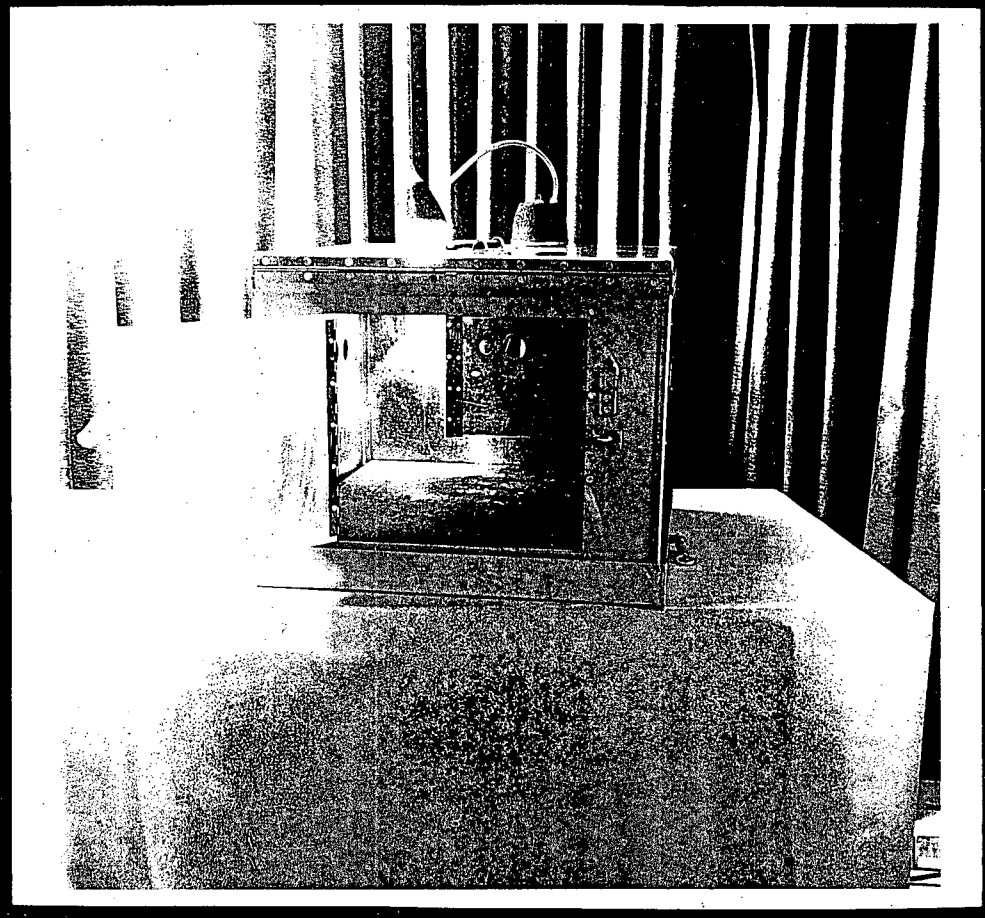

Photo 15

Recall Lamp - Light Diverted into Cage

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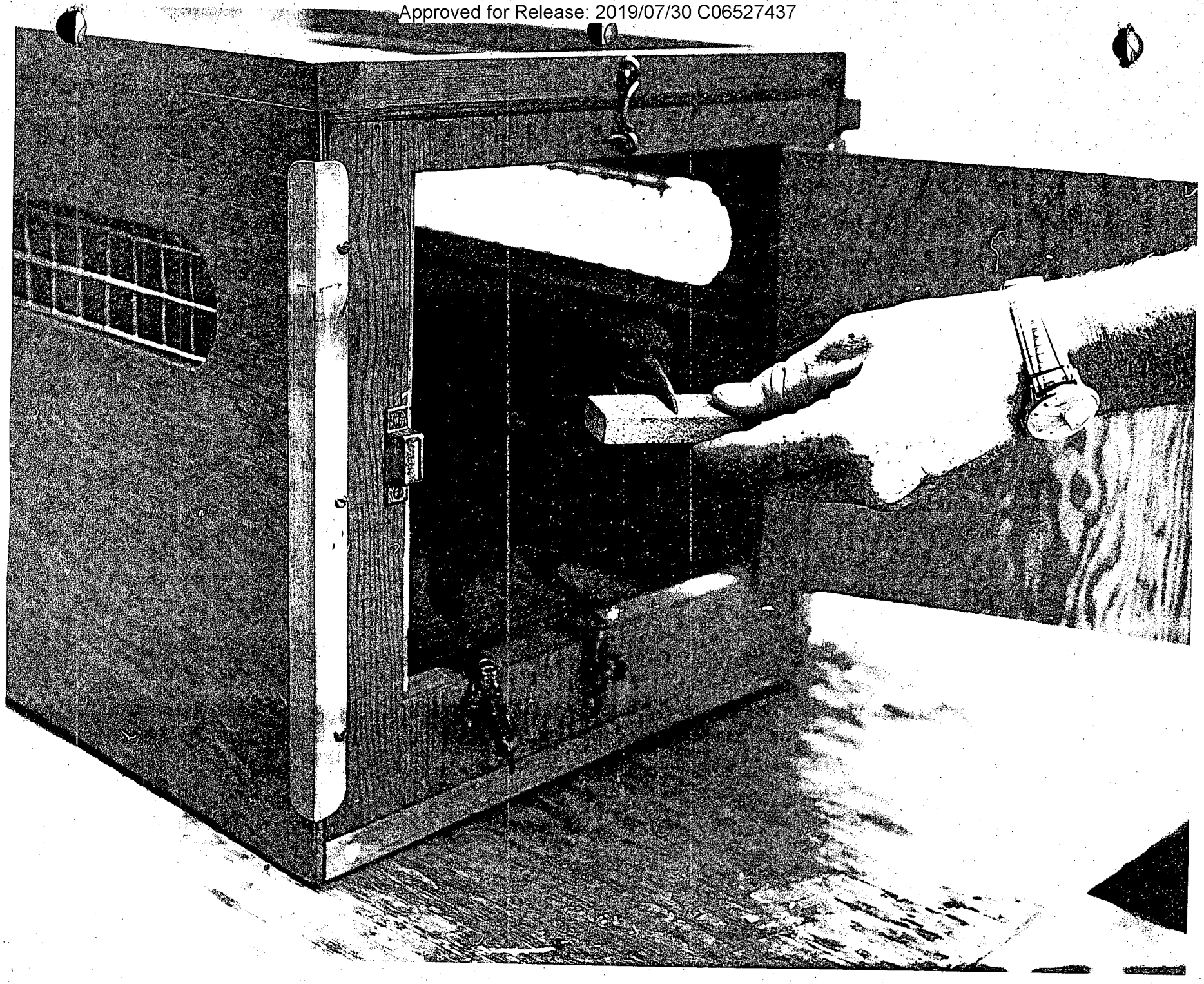

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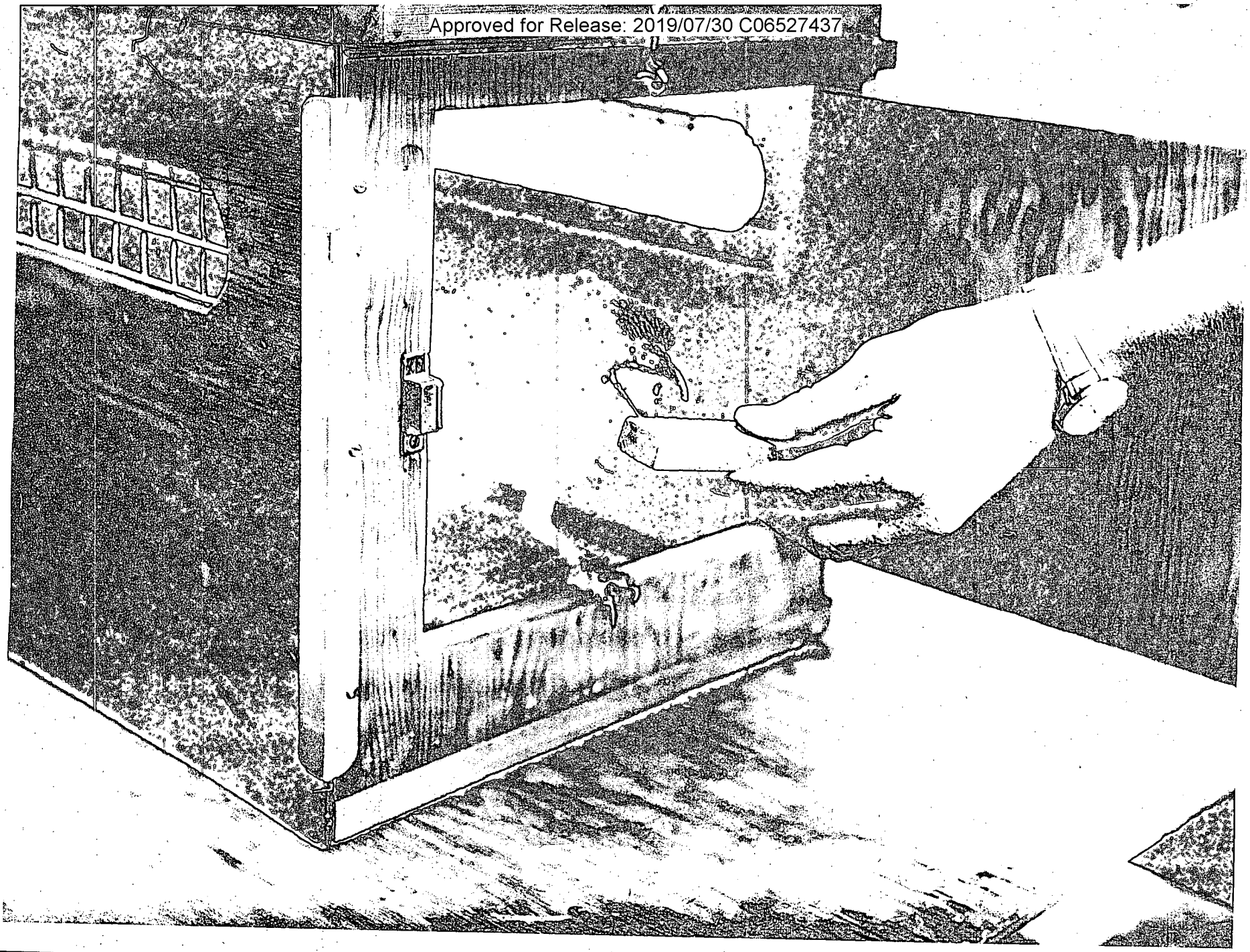

Photo 1
Taking the Package

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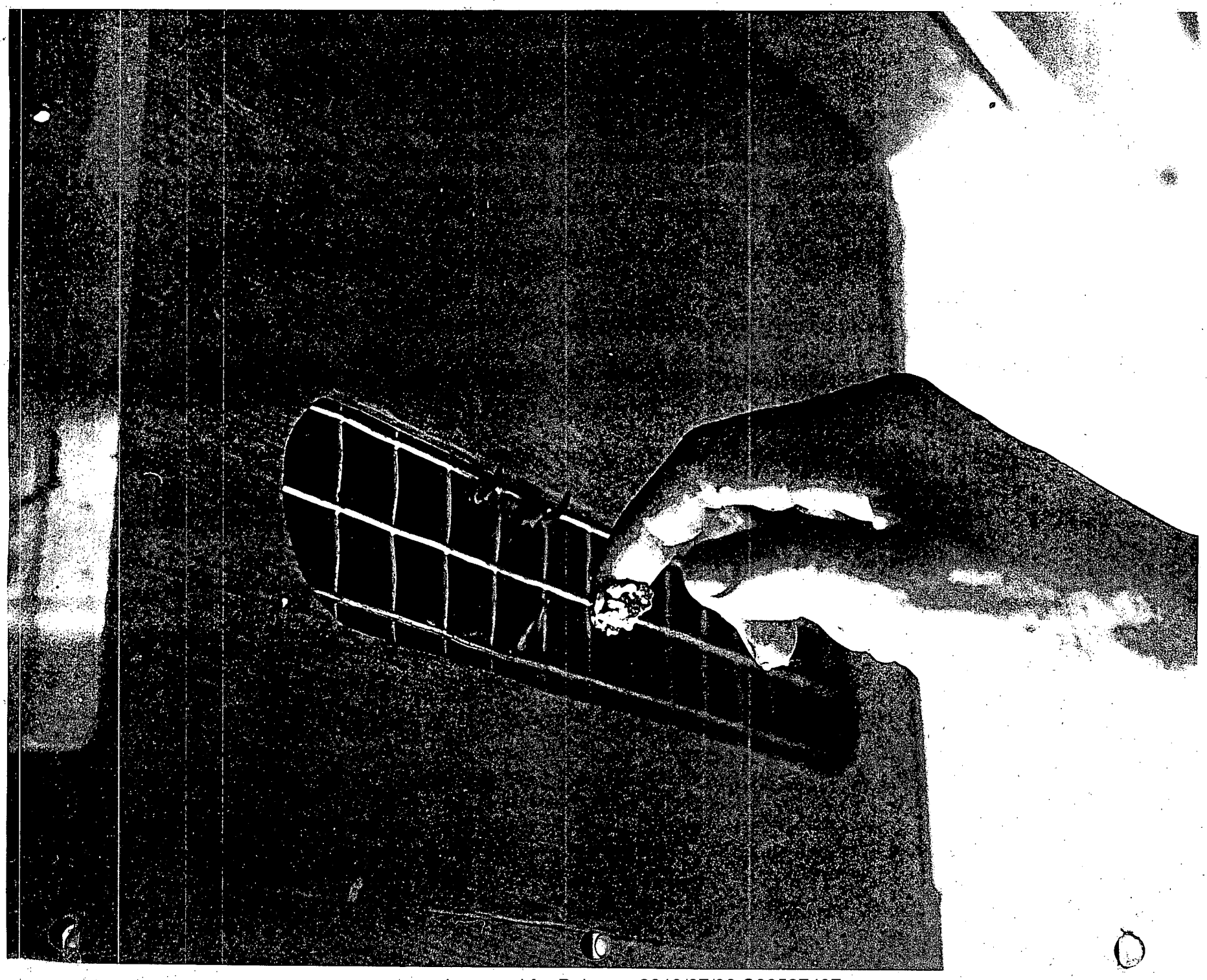

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