

Forest Management Tech Tips

United States Department of Agriculture
Forest Service



**Technology &
Development Program**

June 1998

2400

9824 1303—SDTDC

Powered Guns for Tree Marking

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INTRODUCTION

This document compares and evaluates powered guns having potential to be used with tree-marking paint. These include guns powered by battery, carbon dioxide (CO₂), and compressed air. Information for this Tech Tip was gathered from three sources: field units, in-house evaluations, and manufacturers data.

PROBLEM

Some field personnel have voiced concerns as to whether using manually powered guns over an extended period of time might lead to hand and wrist problems. A simple survey questionnaire was used to gather information on paint gun use in the Forest Service. More than 170 Ranger Districts responded. The results indicated a majority of guns used in the Forest Service are manual. These guns rely on operator strength to pump and propel paint through the gun. Sixty-four percent of those responding to the survey used a Nelspot gun; 25 percent used a Trecoder gun. Hand and wrist pain as well as hard trigger pull were the major problems noted in the survey.

POTENTIAL SOLUTION

Hand and wrist injuries may be reduced by reducing the trigger pull force required to propel the paint and by reducing the weight of the gun. Powered guns use energy stored in compressed gas or batteries to assist in pumping or propelling the paint through the gun, thus reducing the operator force required. In a manual gun the operator supplies the energy to propel paint by pumping the trigger. The trigger on a powered unit functions as a switch, while the trigger on a manual gun functions as a pump lever.

The weight of the gun also contributes to fatigue experienced by operators. All manual and battery powered guns evaluated have a paint reservoir attached directly to the gun. The user must lift the weight of the paint and the gun with their hand when applying paint. The gas powered guns in this test utilize a reservoir of paint carried on the user's back to reduce arm and wrist strain.



DISCUSSION

The tables below summarize physical data on both powered and manual guns. The empirical data provided in the tables should be used for comparison only. Environmental factors such as temperature, affect the performance of the tree-marking systems.

Table 1. Powered paint gun summary.

Powered Gun	Power Source	Capacity	Effective Range	Weight Supported by Wrist During Use	Complete Unit Weight Empty	Flow Rate
Garden Sprayer	battery (4.8 VDC)	1.5 qt (1.4 L)	1 ft (0.3 m)	4.87 lb (2.21 kg)	1.3 lb (0.6 kg)	Not recorded
Krebs	battery (24 VDC)	0.74 qt (0.70 L)	2.75ft (0.84 m)	4.74 lb (2.15 kg)	5.3 lb (2.4 kg)	4.9 mL/sec
Panama Cylindrical Tank	compressed gas	1.5 gals (5.7 L)	5.5 ft (1.7m) @ 30 psi (207 kPa)	1.0 lb (0.45 kg)	13 lb (5.9 kg)	13.3 mL/sec
Panama Elliptical Tank	compressed gas	1.0 gal (3.8 L)	5.5 ft (1.7m) @ 30 psi (207 kPa)	1.0 lb (0.45 kg)	10.8 lb (4.90 kg)	13.3 mL/sec
Prototype Gun	compressed gas	1.5 gals (5.7L)	5.5 ft (1.7m) @ 30 psi (207 kPa)	1.0 lb (0.45 kg)	19.6 lb (8.89 kg)	13.3 mL/sec

Table 2. Manual gun comparison.

Manual Gun	Power Source	Capacity	Effective Range	Weight (gun + full paint can)	Complete Unit Weight Empty	Flow Rate
Nelspot D103	manual	1 qt (946 mL)	6.5 ft (2.0 m)	3.4 lb (1.5 kg)	1.55 lb (0.70 kg)	2.9 mL/sec
Trecoder	manual	1 qt (946 mL)	5.5 ft (1.7 m)	3.0 lb (1.4 kg)	1.2 lb (0.50 kg)	3.0 mL/sec

Notes:

1. Effective range is the maximum measured distance at which the gun/painting system can apply an acceptable mark. Two passes were required for all guns to make an acceptable mark.
2. Flow rate is the rate at which paint flows out of the gun. This is an indicator of the amount of paint used per squirt. The larger the number the more paint is used or applied.
3. Paint used—Forest Service specified low VOC type III.
4. Tests conducted at 70 degrees F.

BATTERY POWERED GUNS

Rechargeable Garden Sprayer

Empty Weight: 1.3 pounds (0.6 kg)

Capacity: 1.5 quarts (1.4 L)

Full Flow Rate: not recorded

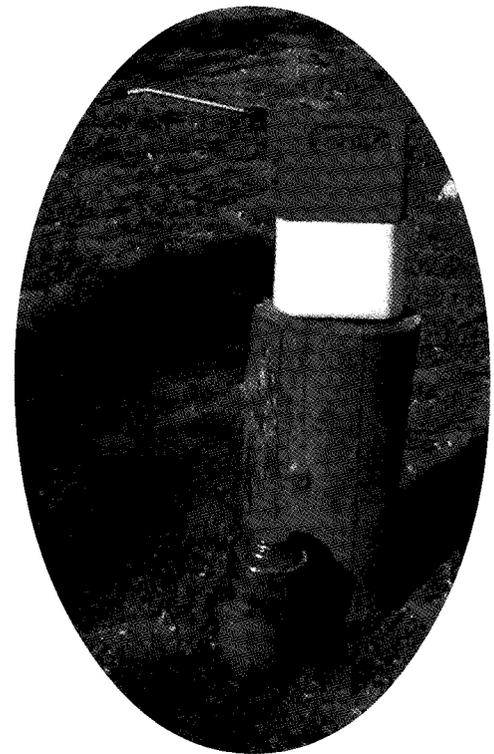
Pump Type: electric motor driven gear pump

Power Source: internal rechargeable NiCad battery pack (4.8 VDC)

Effective range: 1 foot (0.3 m)

The Garden Sprayer (figure 1) is a battery operated sprayer designed for low viscosity fluids such as water. The battery drives an electric motor which is coupled to a gear pump to propel fluid. When used with paint, the motor was over loaded. The sprayer has an effective range of one foot. Since the spray comes out of the nozzle at a relatively low velocity, there is little spray back. Two passes were required to make an acceptable mark. The sprayer uses a switch to turn the motor on and off, consequently it is difficult to control the amount of spray.

This is not a viable replacement for a manual gun because of its short range and excessive use of paint.



*Figure 1.
Rechargeable garden sprayer.*

Krebs Battery Powered

Empty Weight: 2.9 pounds (1.3 kg) gun only; 2.4 pounds (1.1 kg) battery pack; 5.3 pounds (2.4 kg) total weight

Capacity: 0.74 quart (700 mL)

Full Flow Rate: 4.9 mL/sec

Pump Type: vibrating piston

Power Source: rechargeable 24 VDC NiCad battery pack.

Effective range: 2.75 feet (0.84 m)

This sprayer is essentially a cordless version of the common airless paint gun. The sprayer uses a separate battery pack carried on a belt or shoulder strap. The spray tip included with the unit was unacceptable for tree-marking. It was modified to allow the attachment of a larger reversible nozzle from the Nelspot gun for these tests. Two passes or two sprays were required to make an acceptable mark. This could vary depending on the size of the nozzle.

One disadvantage of this type of gun is the pressure can not be controlled. The pump is either on or off, and a low velocity stream for numbering or lettering would require changing the nozzle. The gun is also very heavy and requires the use of an internal battery pack. The manufacturer claims the unit will spray one gallon of paint per charge on the battery pack. One hour is required to recharge the battery pack.

The Krebs battery powered gun (figure 2) is a possible alternative, but would require further development for spray pattern control and to lessen the weight.

COMPRESSED GAS GUNS

These guns use energy stored in compressed gas to propel paint. Compressed air and carbon dioxide are the two most common gasses used. These painting systems use a pressurized tank allowing the user to buy paint in bulk quantities (greater than 1 quart). Purchasing in bulk quantities not only reduces the cost of paint but also reduces the cost associated with paint can disposal.

Using compressed gas reduces the force required to pull the trigger to propel the paint. In a manual gun, the user has to exert force on the trigger to pump and propel the paint. In powered guns, the user only has to exert enough force to open a spring-loaded valve.

This type system has more components than a manual gun which increases cleaning and maintenance. The paint reservoir is difficult to clean because it is fitted with a small filler hole.

When compared to manual guns, these guns use more paint per “squirt”. The user controls the amount of paint sprayed with a manual gun by varying the pressure applied on the trigger. Powered guns do not offer the same control. The spray is controlled by varying the duration of the trigger pull and is dependent on the pressure remaining in the tank.

Powered guns are refillable in the field but require the user to repressurize the system either manually or with a small high-pressure tank.

Panama Cylindrical Tree-Marking Backpack and Gun

Empty Weight: 13 pounds (5.9 kg)

Capacity: 1.5 gallons (5.7 L)

Full Flow Rate: 13.3 mL/sec

Effective range: 5.5 feet (1.7m)

Minimum Working Pressure: 20 psi (138 kPa)

Number of pumps to 30 psi (207 kPa): 240 pumps from empty

The Panama Cylindrical Tree-Marking Backpack and Gun has two main components: a pressurized cylindrical tank and a paint gun. The tank holds up to 1.5 gallons (5.7 L) of paint and may be pressurized using either a built-in hand pump or an outside air source through a valve. The tank is rated at 400 psi (2.8 MPa), however, the manufacturer recommends operating at 125 psi (862 kPa). The gun can operate effectively with a tank pressure of 20 psi (138 kPa). The tank is mounted on a plastic frame and is worn like a backpack. The gun is equipped with a 3/64 inch (1.1 mm) nozzle.

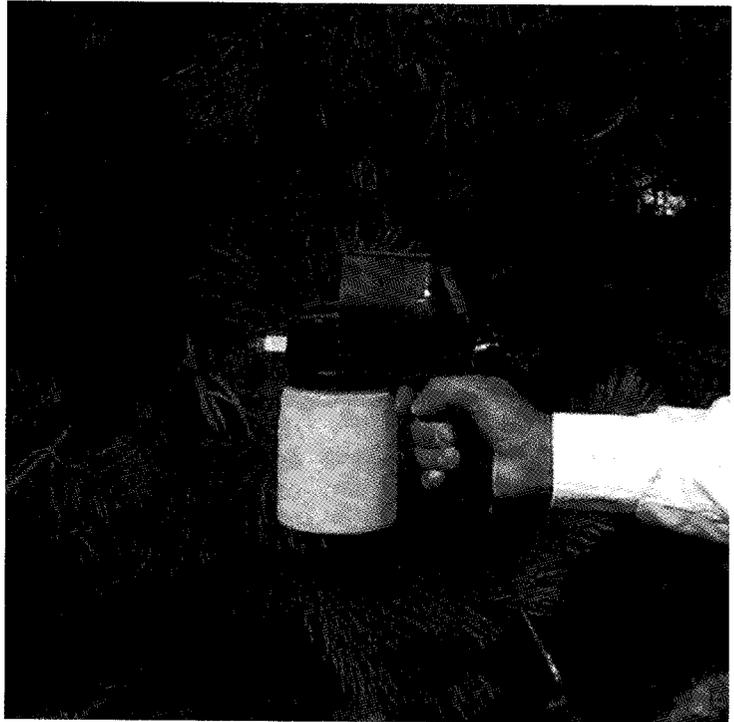


Figure 2. Krebs battery powered gun.

The gun has good range. When compared to a manual gun, more paint is sprayed in one shot. This gun has a maximum effective range of 5.5 feet (1.7m). This is comparable to manual guns. A holster for the gun is not provided, and hanging the gun unsecured could lead to accidental discharge or entanglement. The backpack is uncomfortable for a small-framed person. The straps tend to pinch and the tank may hit the back of the hard hat.

This is a feasible alternative to manually powered guns. Further improvements in the backpack would make the unit more productive.

Panama Elliptical Tree-Marking Gun

Empty Weight: 9.0 pounds (4.1 kg) stainless steel tank; 9.75 pounds (4.42 kg) mild steel tank
Capacity: 1 gallon (3.8 L)
Full Flow Rate: 13.3 mL/sec
Effective range: 5.5 feet (1.7m)
Minimum Working Pressure: 20 psi (138 kPa)
Number of pumps to 30 psi (207 kPa): 200 pumps from empty

The Panama Elliptical Tree-Marking Gun differs from Panama's Cylindrical Backpack Gun in tank configuration and capacity. The elliptical tank is not mounted on a frame. When taking field measurements the tank tends to move and slide around on the marker's back. Factory straps only secure the tank in place when the user's back is straight.

The elliptical tank can only be pressurized with the built in hand pump. This tank has a capacity of one gallon and is rated at 100 psi (690 kPa). The manufacturer recommends operating the gun between 30 (207 kPa) and 60 psi (414 kPa). Tests have shown however that the gun operates at 20 psi (138 kPa). This unit uses the same paint gun as the previous Panama backpack unit. As with other powered guns, this tree-marking gun has a lighter trigger pull and has an effective range comparable to manual guns.

Because the elliptical tank is fifty percent smaller than the cylindrical tank it is more likely to require refilling in the field. Each member of a typical marking crew carries 6 to 10 standard quart cans of paint for a day of marking. Maintenance and cleanup requires more time because there are more parts to clean.

This tank configuration is a viable alternative, but improvements in the harness and carrying system are recommended.

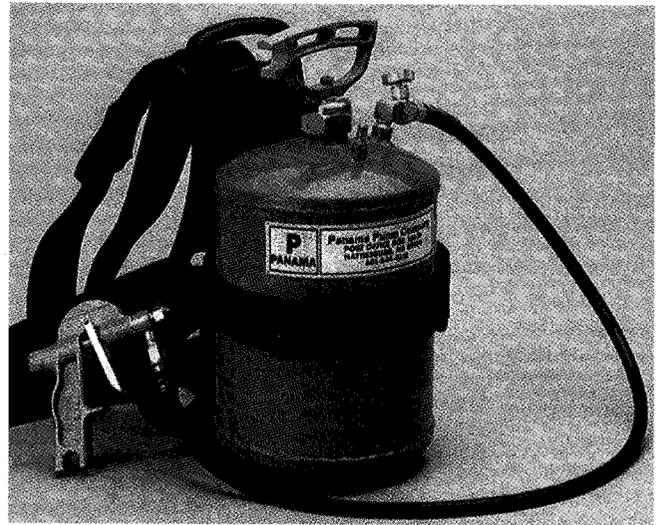


Figure 3. Panama tree-marking guns.

Region 9 Modifications to the Panama Cylindrical Tree-Marking Backpack and Gun

The Florence Ranger District, Nicolete National Forest in Region 9 made two modifications to the Panama Cylindrical Tree-Marking Backpack and Gun configuration. The first modification was to replace the frame with a military type A.L.I.C.E. frame and add more padding to the shoulder area. Aluminum conduit was used to fabricate a tank holder and carrying handle. The tank can be mounted high or low on the frame to suit the user. This frame design provides more support and is lighter weight.

The second modification replaced the compressed air with compressed CO₂. A pressure relief valve was added and the fill valve for air was relocated. The built-in hand pump was removed. The marking crew in this district refills the tank with CO₂ stored in a high pressure (1800 psi/12.4 MPa) tank mounted on a pickup truck. The high pressure tank has a regulator with two pressure gages; one reads tank pressure, the other reads regulated fill pressure. The advantage of CO₂ is that CO₂ provides significantly more fills than an air tank of the same size and pressure. Carbon dioxide is in both a liquid and gaseous phase in the high pressure tank. If temperature is held constant, the pressure remains the same as the gas is removed, until all the liquid CO₂ has evaporated. Air, on the other hand, only exists in the gaseous phase; the pressure drops as air is removed.

The pressure relief valve is necessary for safety. A pressure relief valve which opens well below the rated pressure of the tank was selected. When the temperature of the gas increases, the pressure in the tank increases. To avoid failure in the structure of the tank, the pressure relief valve relieves excess pressure when a predetermined level is exceeded.

This unit was not tested, however performance should approach the Prototype Backpack Gun.

Prototype Backpack Gun

Empty Weight: 19.6 pounds (8.89 kg)

Capacity: 1.5 gallons (5.7 L)

Full Flow Rate: 3.3 mL/sec (Panama gun)

Effective range: 5.5 feet (1.7m)

Minimum Working Pressure: 20 psi (138 kPa)

Number of pumps to 30 psi (2.7 kPa): 240

The Prototype Backpack Gun (figure 4) is a further modification of the Region 9 unit. The tank is fitted with a pressure relief valve and a “welding” type pressure regulator. The tank is filled initially with CO₂ from a large high-pressure CO₂ tank. While in the field small CO₂ tanks are connected to the regulator and provide constant working pressure automatically. The working pressure can be adjusted with the regulator depending on user preference and field conditions. A double action hand pump may also be used to fill the tank with air. This hand pump differs from the original Panama hand pump in that the handle is located beside the user’s arm allowing



Figure 4. Prototype backpack gun.

the user to repressurize the tank while walking and wearing the backpack. The Prototype Backpack Gun is a prototype and weight was not a consideration. The primary design concerns were the function of a dual CO₂ and air system and the double action pump. SDTDC anticipates refining this design in FY99.

This tree-marking system is a viable alternative to manual guns. Using CO₂ and a double action pump makes it easier to maintain a working pressure. Tank configuration should be improved to facilitate filling and cleaning.

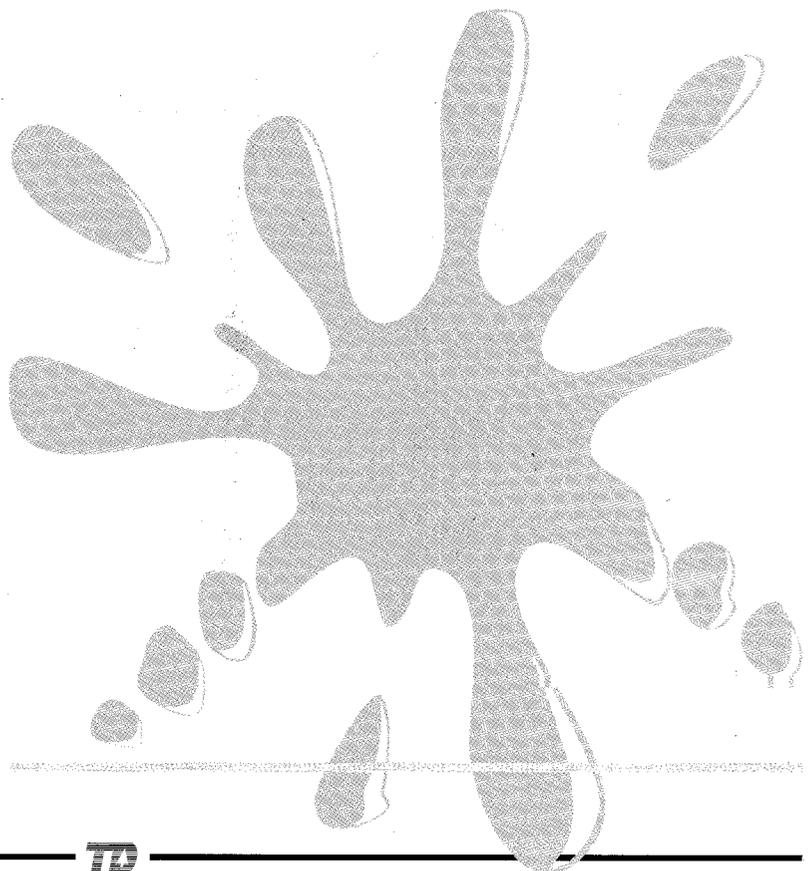
CONCLUSION

Compressed gas backpack guns are viable alternatives to manual paint guns. Improvements in the backpack and tank configuration are recommended. These compressed gas guns have comparable range to the manual guns. Trigger pull-force is lower and the gun itself is lighter in the user's hand. User fatigue is reduced by reducing the force required to pull the trigger. Further documentation is available from SDTDC.

Battery powered guns have very short range and carry limited quantities of paint. Their power source is not easily replenished in the field. Battery powered guns either have to be recharged or have a spare battery available.

Powered guns require smaller trigger pull force to propel paint. However, the powered guns do not have the control over the spray. Powered guns either are on or off and the user can not vary the spray by varying the force exerted on the trigger. Powered guns typically have a larger reservoir of paint carried on the user's back allowing the guns on the powered units to be lighter weight than manual guns. The lighter weight would reduce fatigue associated with manual guns by reducing the weight the user must lift every time paint is applied. Tree markers typically carry quart cans of paint in their backpacks. The weight of a backpack gun, especially on a properly fitted frame would probably not increase user fatigue. Storage of personal items could be incorporated into the backpack guns.

The larger paint reservoirs used in the powered system permits the users to procure paint in bulk which is typically less expensive than buying paint in individual quart cans. Using bulk quantities reduces the effort required to track paint since there are fewer cans.



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