

Knapsack-Type Power Applicators in Japan

By MAKOTO ARIYOSHI

Chief, 3rd Testing Laboratory, Testing Division,
Institute of Agricultural Machinery

Power pest control machines are widely used lately in Japan. Especially the increase and spread of highly efficient pest control machines have been remarkable for saving labor in pest control.

The knapsack-type power applicators, above all, have become extremely popular with the increase of their production for the last few years since their economical advantages have been recognized not only because they are reasonable in price and so handy that they can be operated by a small number of laborers but also because they are of high efficiency of multipurpose utility as the result of the development and improvement of the boom-type blow heads.

This paper deals with an outline of the structure of the knapsack-type power applicator and also the result of the test conducted by the Institute of Agricultural Machinery under the I.A.M. testing code which was established in 1967 by this Institute.

Structure and specification

Most of the knapsack-type power applicators now on the market are of the standard type equipped with three kinds of operating equipment; namely, the equipment for dusting of powder chemicals (with a single type dusting blow head), the equipment for application of granule chemicals and the equipment for mist application of liquid chemicals. There are many other types of machines which have special equipment capable

of flaming weeds, mowing and fog application in addition to the above-mentioned operating equipment.

As to the structure, the applicator consists of a blower, a chemical hopper tank, a discharge control mechanism to control discharge rate, a blow pipe and blow head for chemical application, an engine for driving the blower, and a knapsack frame to fix the above equipment and a knapsack band to carry them on the back. To show the structures of the equipment in their respective operations, an outline is given as follows:

1) Equipment for dusting operation

There are two types of equipment for dusting operation, a single hole blow head dusting equipment (hereinafter referred as single hole dusting) which is handled by one person and a boom-type blow head dusting equipment (hereinafter referred as boom type dusting) which is handled by two persons.

The single hole dusting equipment has a curved pipe fitted to the blower discharge port with a blow pipe and a blow head made of steel sheet or hard vinyl chloride fixed to it by a flexible pipe made of rubber or synthetic resin. The size of the blow pipe is just enough to hold in one hand, and its length is about 1.4~1.6 m apart from the knapsack frame.

For application, the operator carries the machine on his back, holds blow pipe in the right hand and walks back or forth, while dusting, with the pipe swinging to the right and left.

The swath width is 5~7 m.

As to the boom-type dusting equipment, a flexible pipe is directly fitted to the blower discharge port, and to the tip of this pipe is fixed a boom-type blow head made of polyethylene, of 20 to 40 m long, 90 to 120 mm in folded width and 0.08 to 0.1 mm in thickness, with holes at the underside at regular intervals. The application work is done by two persons, one holds the tip of the pipe and the other carries the machine on his back and walking along the levee to make application.

2) Equipment for granule application

Most of the granule application equipment are of the dust-granule convertible type, only replacing the blow head on the tip of the single hole dusting equipment with that of the diffusion-type blow head for granule application. Some of them have a flexible pipe

ing equipment, but some granule application equipment have control mechanisms for their own use.

3) Equipment for mist application

For mist application, the blow head on the tip of the single hole dusting equipment is replaced with a mist blow head which is fitted with a mist nozzle, and on this blow head is fixed a cock for control of spray. The chemical tank can take the place of the one for dust application. But some tanks are mist application only. As for the liquid feeding method, there are such types as to give pressure on the tank by utilizing the blowing air, by the exhausted gas of the engine or by a separately fixed rotary pump of small size. The type most generally used among them is the one applying pressure by utilizing blowing air (Fig. 1).

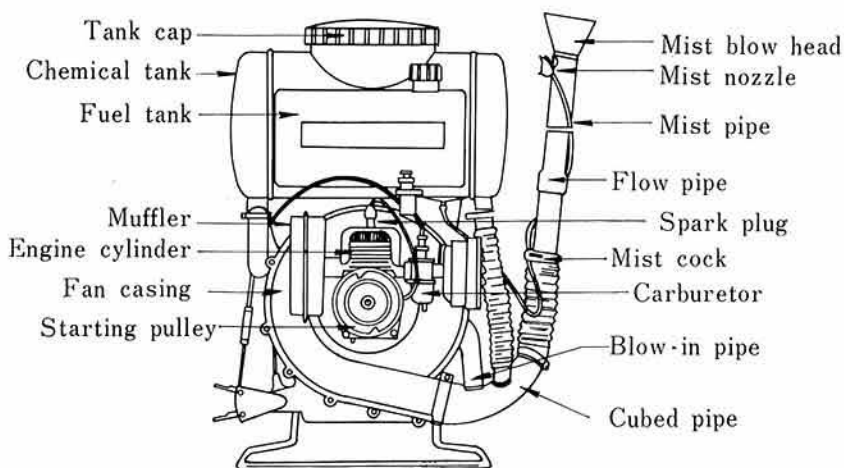


Fig. 1. Knapsack type power applicator in mist working equipment.

fitted to the blower discharge port after taking off the curved pipe of the blower and a diffusion type blow head fixed directly on the tip of this flexible pipe, and the application is done with the head at the right angle with the advancing direction.

The chemical hopper tank for dusting use is also utilized for granule application in most cases, and the discharge rate control mechanism is mostly the same as that of the dust-

4) Other operating equipment

The IAM test in 1967 was conducted only for the above-mentioned three operating equipment, dusting, granule application and mist application. A test on the other equipment was not carried out on actual machines, but a survey was made according to the applications for test from manufacturers or with catalogues. The available operating equipment other than the three kinds mentioned

above are equipment for flamingweed, a mowing equipment and fog application equipment.

Outline of structure

1) *Weight*

Since a knapsack power applicator is operated by a farm worker on his back at the farm, it has been desired to reduce the weight of the machine. For the machines now in use, light alloy and synthetic resin are used wherever they may be possible, and therefore the weight of the machine is considerably decreased.

The weight of the machines which were put on test ranges from 9.5~14.7 kg (in case of single hole dusting equipment, excluding chemicals) and its average is 12.2 kg. The machines weighing about 10 kg are small types with the engine output of 1 to 2 PS while those of about 14 kg in weight are large types with the engine output of over 3 PS.

As shown already, the weight of these machines is drastically reduced compared with that of the old types, but it seems that there are some differences as to massiveness and fatigue to be felt by the operator with the machine on his back according to the position of the center of gravity of the machine itself or its adaptability to the operator's physical conditions. As for the appearances and sizes of the machines, not so much differences are found except in the case of the small type machines and there are no factors which influence difficulty of operation.

2) *Blower*

The blower is a single sided centrifugal blower of horizontal type, and driven directly by engine the impeller being directly fixed on the crank shaft. The impeller is 220 to 240 mm in diameter and 10 to 16 in number.

There are three different shaped impeller blades—forward pitched straight blades, backward curved blades and backward pitched straight blades. The blower discharge port is 55 to 65 mm in diameter.

The normal speed of the blower is according to respective works, and there are two types; one in which the speed is controlled by changing the position of the engine throttle for respective works, and the other in which the position of the engine throttle is fixed in any work and the discharge air flow rate and the input horsepower are changed by replacing the blow heads.

In the latter case, the input horsepower is reduced but the speed is increased as the resistance of blow heads gets larger and the discharge air flow becomes smaller. As for the materials of impellers and casings, aluminum alloy casting (including die casting) is most generally used, and it is rare to use iron.

3) *Chemical tank*

There are two kinds of chemical tanks, one that is used in common for dust, granule and liquid, and the other used only for dust and granule chemicals. There is another tank for liquid chemicals.

In both the common use type and the type with a separated tank, the troubles required in replacing the working equipment do not vary so much because the discharge control mechanism must be changed when an operating equipment is replaced with another. The tank is fixed with rubber bands or bolts and it is easy to remove. The materials of the tank are synthetic resin, and its cap is of screw type. The Nozzle of the tank for filling in chemicals is about 130 to 150 mm in diameter. The capacity of the tank is 10 to 12 liters.

4) *Discharge control mechanism*

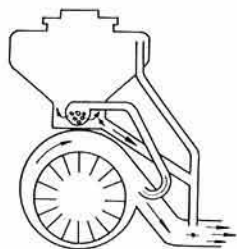
For feeding of chemicals from the chemical tank to the blower discharge port, two methods are employed; one is the method without rotary part (a blow-in feeding type, a gravity feeding type and a blower feeding type) and the other is the mechanical feeding method. At present, the former is generally used because it has many advantages such as the lighter weight, less troubles and the lower cost. But, on the other hand, this

method has such a weak point that the discharge rate may change according to the properties of the chemicals in case of dust and granule application, and in case of mist application the discharge rate varies according to the position of the blow head in holding it.

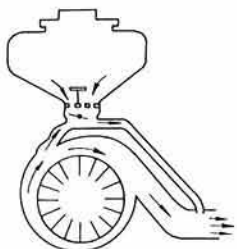
(1) Feeding method of dust and granule chemicals

(a) Blow-in feeding type (Fig. 2-A)

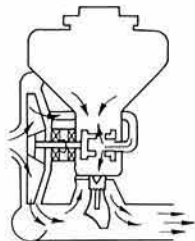
A stream of the blowing air is blown into the bottom of the tank and by this air stream, dust chemicals are stirred, making a mixture



A) Blow-in feeding type



B) Gravity feeding type



C) Mechanical feeding type

Fig. 2.

of air and dust which is blown into the blow pipe through the shutter.

(b) Gravity feeding and blow-in feeding type (Fig. 2-B)

By preventing the dust chemicals from settling with a guide plate at the bottom of the tank, the dust is made to fall through the shutter by its own gravity and by vibration, and blown into the blow pipe by the air stream.

(c) Blow-in and mechanical feeding type (Fig. 2-C)

The dust is loosened by revolving the agitator at high speeds, and the air is blown in from within the agitator and the dust is mixed with the air forming mixture which is blown into the blow pipe through the shutter.

(2) Liquid feeding method

(a) Blower feeding type (Fig. 3-A)

The pressure of the blowing air is led to the top of the tank and given to the surface of the liquid chemicals, which are let out from the bottom of the tank by the cock and guided to the blow head to jet out.

(b) Pump feeding type (Fig. 3-B)

This type is equipped with a rotary pump for applying pressure. The liquid chemicals taken out from the bottom of the tank is given pressure with the pump and led to the blow head to jet out.

(c) Feeding by exhausted gas (Fig. 3-C)

The exhausted gas in the engine muffler is guided to the top of the tank through the check valve. Its pressure is given to the surface of the liquid and the liquid is taken out by the cock and led to the blow head for jetting out.

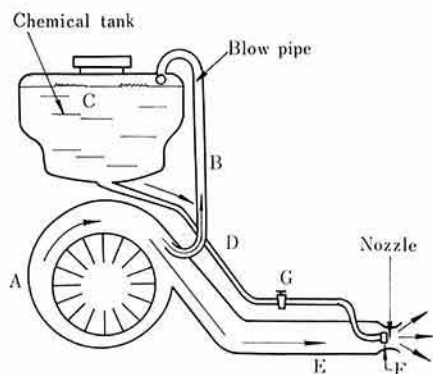
Among the chemical feeding methods described above, the blow-in feeding type is generally used for dust and granule chemicals, and the blower feeding type is mostly used for liquid chemicals.

For feeding liquid chemicals are sometimes fitted with the equipment (b) and (c) mentioned above as a special order.

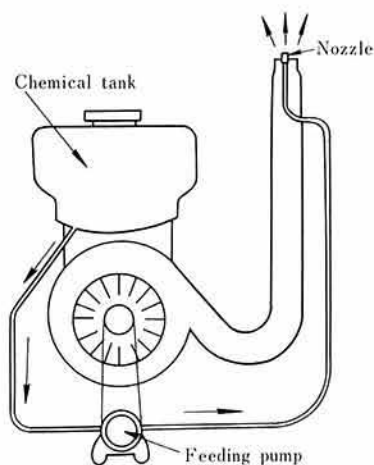
5) Blow head

(1) Boom type blow head

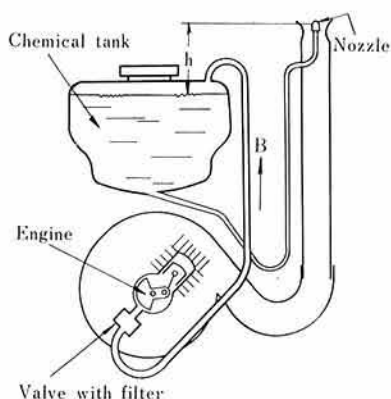
Most of the holes of the boom type blow heads are at regular intervals of 300 mm and



A) Blower feeding type



B) Pump feeding type



C) Feeding by exhausted gas

Fig. 3.

some are at 250 mm or 400 mm intervals. The folded width of the hose (the width when it is folded) is 92 to 123 mm and the swath is 20 m to 40 m.

(2) Single type dusting blow head

Most of the single type dusting blow heads have curved heads, sometimes with a Y-blow head as a special equipment for drift application and application on stump portion.

(3) Blow head for granule application

The most popular blow heads for granule application are the single type blow head which is the same as the head for dusting and the one which has either a fan shape blow head for spreading out granule chemicals or a diffusion type blow head. Lately, another type of blow head has been introduced and increasingly in use. This type is equipped with a head that can apply granule chemicals in the width of 20 to 30 m at a time by a hose made of polyethylene resin, similar to the boom type blow head for dusting use.

(4) Blow head for mist application

There are two types of blow head generally used for mist application, that is, straight type blow head and diffusion type blow head. In replacing the straight type blow head with the diffusion type blow head, there are various methods such as by exchanging the diffusion pipe on the blow head, or by moving the position of the diffusion pipe back and forth exchanging the misting net, or exchanging the misting propeller. As for fogging mechanism, there are nozzle misting plate and misting propeller types.

6) Engine

The engine in general use is of air-cooled, 2-cycle single cylinder type using fuel of 20:1 mixing ratio. A rope starter or a recoil starter is equipped for starting. The most important problem is how to make the air cleaner dust proof for the knapsack power applicator. In this case, a system of filtering air by sponge is adopted for dust sealing. There are various methods for cleaning sponges—by water, oil or mixed oil.

7) *Knapsack equipment*

The knapsack frame is made of steel pipe, and 4 pieces of rubber are fixed on it for absorbing shock. Upon this frame are fixed a blower, an engine, and a tank, etc. The back cushion is made of polyurethane foam covered with vinyl leather which is 300 to 350 mm square in size.

The knapsack band is made of vinyl belt with cloth wrapped in, 40 mm wide, and its length can be freely adjusted with a buckle.

A shoulder cushion made of sponge, about 60 to 200 mm long, is attached to the knapsack band in part with which the shoulder comes into contact.

Field Performance

Field performance for knapsack-type power applicator is expressed in the following equation:

where

$$V = \frac{1000 \times q}{60 \times L \times G}$$

V : Travelling speed (m/s)

L : Swath width (m)

G : Amount of chemical applied per 10 ares (kg or liter)

q : Discharge rate from nozzle or head (kg or liter/min)

However, the equation excludes turning time and the time required for supply of chemical into the tank. The test results showed that (1) discharge rates were 0.2 to 5.0 kg/min and 0.2 to 5.0 liter/min for dust or granule and liquid respectively, and (2) swath widths were 20 to 40 m and 5 to 7 m for boom head and single hole blow head respectively.

Travelling speeds were selected at 0.2 to 0.4 m/s for single hole blow head application and 0.4 to 0.6 m/s for boom type blow head application.

Summary

Lately, the performance of knapsack-type power applicator has been greatly improved due to the introduction of the boom-type blow head and smaller and lighter engine with higher output and low fuel consumption.

The reduction of the weight of the whole machinery has been effected by the use of synthetic resin, and the improvements of shock absorbing device together with the improved handling system. As the result, the reliability of this type of machine has been greatly increased.

However, there are still a few problems yet to be solved.