THE TERRAMATIC (R) * BOOMSPRAYER - AUTOMATION IN AGRICULTURE

A.W. HUMPHRIES and P.D. WEST

Terra Trading Co. Pty. Ltd.,
P.O. Box 92,
Victoria Park. W.A. 6100.

INTRODUCTION

Boomsprayers as normally designed and manufactured present a series of problems and difficulties which are not generally recognised or understood, except by the long-suffering user.

These include:

* Complicated calculations involving ground speed, nozzle output, chemical application rate and water volume.

* Calculation of the correct amount of chemical concentrate to be added to the vat.

* Accurate measurement of quantities of chemical and water required.

* Health hazards in measuring and pouring concentrate chemicals, and the associated risks of physical injury.

* Ground speed must be maintained accurately, regardless of the terrain or other relevant conditions.

* Accurate calibration is essential and difficult.

* Where a tank mix is indicated, e.g. for grass and broad-leaved weed control, the user has no means of saving the application of one in areas where it is not needed.

* The area left to spray at the end of a job must be estimated accurately to avoid chemical wastage (and needless environmental pollution).

* A potentially useful water carting-firefighting tank is unuseable because of chemical contamination.

Boomsprayers with a ground-drive pump provide a fairly satisfactory solution to the ground speed control problem, but introduce other difficulties, notably that of unwanted fluctuations in pressure at the nozzles, and lack of agitation of the spray mixture when stationary.

(R) Registered Trade Mark
* Australian Patent No. 533781

DESIGN OF THE TERRAMATIC BOOMSPRAYER

Concepts. Most of the problems listed have been addressed in the design of the Terramatic boomsprayer. This machine incorporates concepts which are novel, and which have been realised in what we believe is the first truly automatic boomsprayer in the world.

The central design concept was to separate the chemical and water circulation systems, both to avoid contamination of the water, and more importantly, to allow the concentrate chemical(s) to be metered independently and automatically.

Main features of the Terramatic system are shown schematically in Diagram 1.

Compressed air functions. Air from the compressor performs four main functions:

i. It provides the power to inject chemical concentrates straight from the supplier's drum to the chemical vats on the Terramatic.

ii. It provides chemical concentrates under pressure to the chemical metering pumps;

iii. It powers the pneumatic rams which engage and disengage the chemical meter drive wheel from the ground wheel;

iv. It provides the air supply for the foam bout marker

Chemical metering pumps. The two chemical metering pumps on the Terramatic operate completely independently of each other, so allowing two or more chemicals to be applied at different rates. Drive of the meters is by means of a small wheel running on the upper surface of a trailer ground wheel. This has a great advantage in maintaining accuracy under a range of field conditions, because the meter output relates to the perimeter of the ground wheel, rather than its rate of rotation. This means that the build-up of mud, for example, has negligible effects on the rate of chemical dosage.

The meters are piston pumps, this pump genus having been used for liquid metering in many fields for many years. However, in application to agricultural chemical metering, two problems arise which render most metering pumps unsuitable.

i. The wide range of piston speeds imposed by ground speed changes present cavitation problems at higher speeds; i.e., the cylinder tends to be incompletely recharged for the next stroke.

ii. Agricultural chemicals span a wide range of specific gravity and viscosity values.

Both of these problems can cause gross errors in metering performance. Our solution, which has proved highly satisfactory, was to "force-feed" the pumps using compressed air at 180 kPa to inject the chemical concentrates into them. A straight-line relationship between pump speed and output has been achieved, using chemicals as diverse as 2,4-D Amine and highly viscous suspension concentrates

The rate of chemical concentrate application is set by means of a cursor on a quadrant-type dial, the maximum range normally supplied being from 0.25 to 3 L/ha - 1. Adjustment of the cursor alters the length of stroke of the piston, so modifying the output per piston stroke.

To avoid any pulsing effect on the rate of output of chemical, the meter pistons are designed for higher speed operation, in the range of 3 to 5 strokes per second.

With the metering system as described, it is essential to bleed any air from the system before commencing operation. This is done by hand-turning the meter drive wheel for a few revolutions, draining the expelled air/chemical mixture back into the original drum. Only a few mls are involved. The same air bleeder outlet allows any surplus chemical concentrate to be returned to the supplier's drum at the end of a spray job, so avoiding the need for guesswork and the risk of any chemical wastage.

Chemical-water mixing. The chemical concentrates metered from the metering pumps is injected through (separate) venturi inlets into the water stream, at a point just prior to entry to the boom line. The venturi ensures there is no back pressure applied to the chemical meters, and also assists thorough mixing with the water. Colorimetric testing of prototypes established a consistently uniform mixing of the chemicals and water.

Materials. The use of concentrated chemical circuits in the design of the Terramatic imposed severe demands on materials, and much time was spent in procuring and testing materials. Nylon, Viton A, brass, and stainless steel components have proven highly satisfactory.

Other design features. Because the chemical vats are pressure vessels, subject to 180 kPa air pressure, conventional methods of level sensing and agitation of vat contents, were not applicable. This led to the design of an electronic level sensor, and the use of an electrically driven agitator pump. Both of these have substantial advantages over older methods, including a read-out of vat contents on the tractor dashboard.

LIMITATIONS OF THE DESIGN CONCEPT.

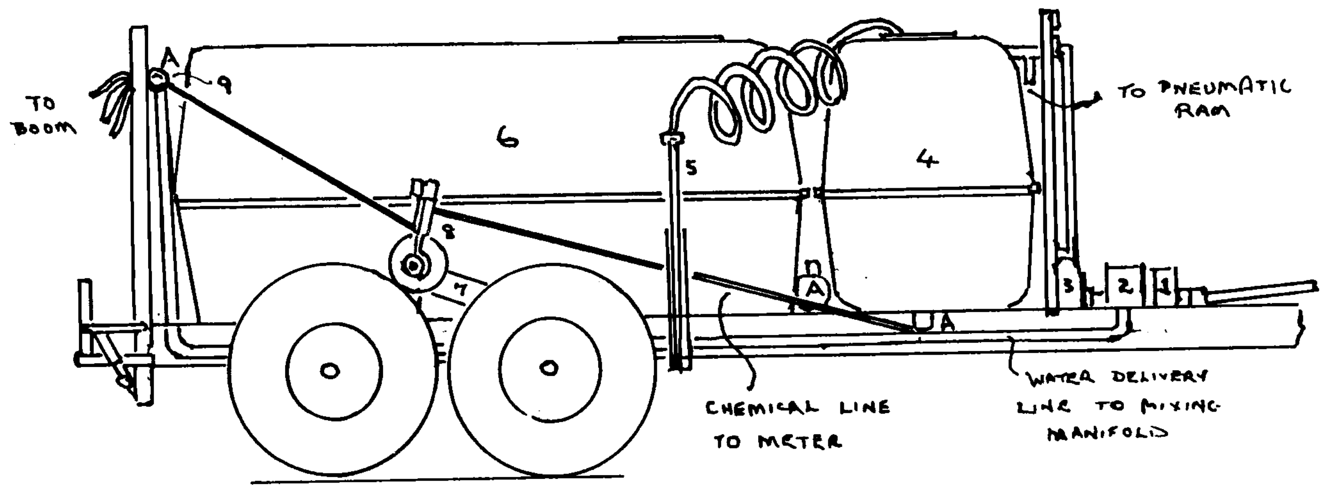
Two main limitations are inherent in the Terramatic design concept.

Variable rate of water application. Because the water system is based on a conventional design, where pump output is pre-set at the commencement of a spray job, changes in ground speed induce proportional changes in water output per hectare. Calculations made on a theoretical basis showed this to be no problem over a reasonable but wide range of ground speeds. Experiments and field experience in W.A. show that water volume is not critical for most herbicides over a range from about 30 to 100 L ha - 1. The user sets the water rate at a conservative point, and we have not had a single report of any difficulty.

Lag in adjustment of chemical rate. Chemical application rates at variable ground speeds are kept constant in the Terramatic system by adjusting the concentration of chemicals in the water stream. This means an inevitable lag in reaching the correct concentration when the ground speed is altered. To minimise this, we use 9.5 mm tube to supply the boom line, and the chemical-water mixture is injected at three spaced points to ensure even distribution, and to minimise pressure drops. With an 18 m boom for example, a change in ground speed from 12 to 18 kph at an output of 50 L ha - 1 means a lag time of c. 4.2s, or 21 metres travelled. This hardly rates as a serious problem.

TERRAMATIC[R] BOOMSPRAYER

SIMPLIFIED SCHEMATIC SIDE ELEVATION



1. DRIVE COUPLING
2. WATER PUMP
3. AIR COMPRESSOR
4. CHEMICAL VAT (1 of 2)
5. CHEMICAL FILLING PROBE
6. WATER TANK
7. PNEUMATIC RAM
8. CHEMICAL METER
9. MIXING MANIFOLD

A. FILTERS (3)