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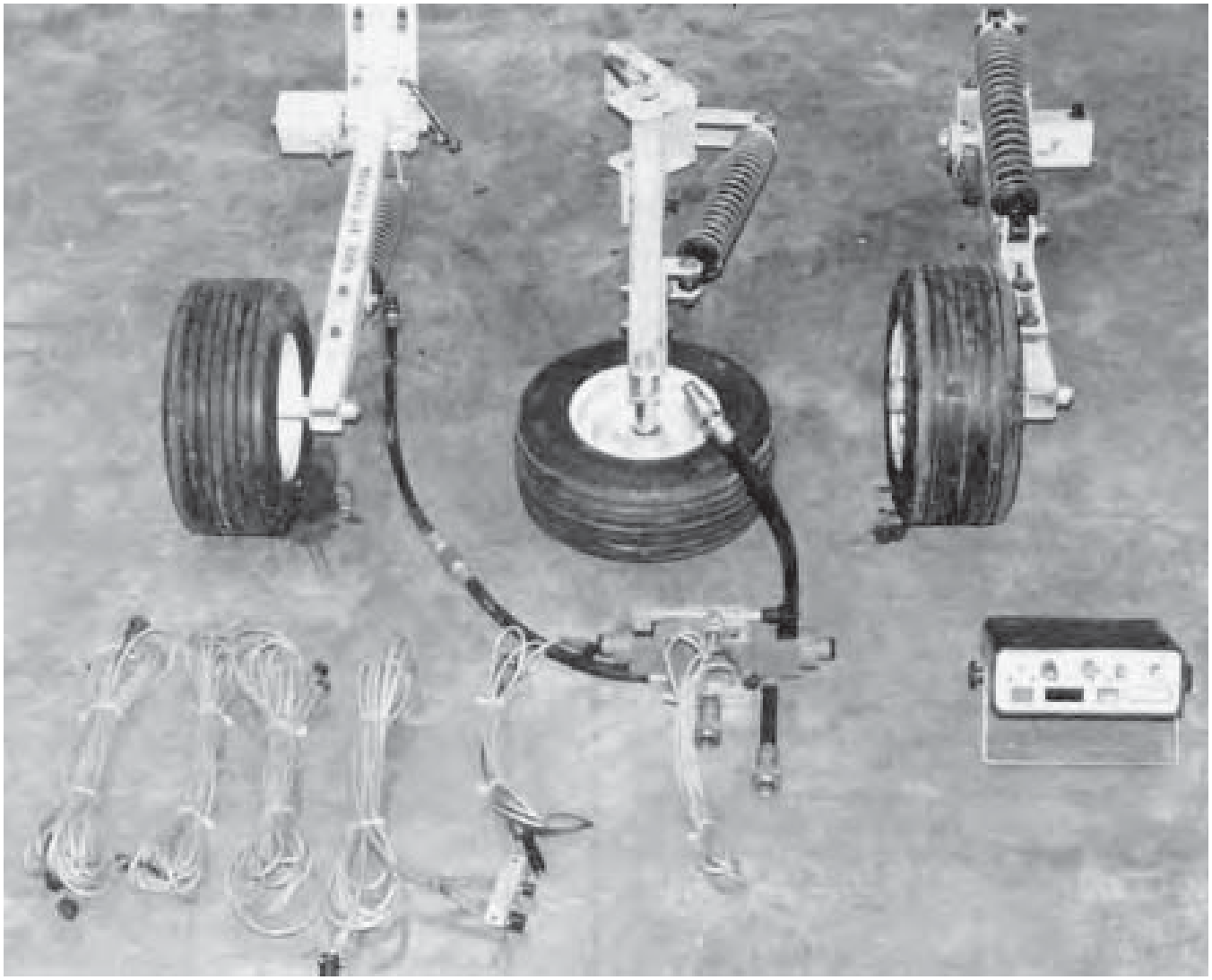

Depth Master Automatic Depth Control System

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

DEPTH MASTER AUTOMATIC DEPTH CONTROL SYSTEM

MANUFACTURER AND DISTRIBUTOR:

Inventronics Sask. Ltd.
Box 1750
1955 Caribou Street
Moose Jaw, Saskatchewan
S6H 7K8

RETAIL PRICE:

$2750.00 (March, 1986, f.o.b. Lethbridge, Alberta).

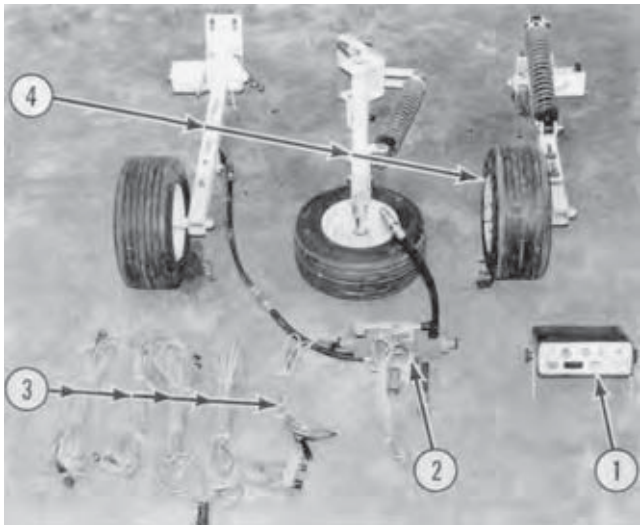

FIGURE 1. Depth Master Automatic Depth Control System: (1) Control Console, (2) Electro-Hydraulic Solenoid Valve, (3) Cables, (4) Gauge Wheels.

SUMMARY

Performance: Functional performance of the Depth Master automatic depth control system was good. Performance was reduced when working in moist conditions due to soil build-up on gauge wheels.

Installation: The Depth Master was easily installed by one man in about four hours. No modifications to the tractor or implement were required.

Seed Placement Accuracy: Seed placement accuracy depended on soil conditions. More uniform depth of seed placement resulted when using the depth control unit in varying soil conditions. No difference in seed placement was obtained with and without the depth control in firm soil conditions.

Response: The depth control unit response was acceptable for all types of conditions encountered.

Field Variables: Error in average depth could result when travelling along field ridges. The automatic depth control unit performance was improved when travelling at an angle to field ridges. Similar error in average depths occurred when one cultivator section (one gauge wheel) encountered an extended hard area in the field that it could not properly penetrate. Due to cultivator frame geometry, the depth control system could not effectively maintain a uniform depth through gullies and over sharp hill crests.

Ease of Operation and Adjustment: Control system operation and adjustment were easily performed. An experienced operator could adjust the depth control unit to suit most field conditions in lest than five minutes. Implement depth adjustments were easily made from the tractor cab. Approximate depth of tillage could be read from the digital display.

Operator Safety: The Depth Master was safe for field and transport use. Implement safety lock-ups should be used to ensure safe transport.

Operator's Manual: The operator's manual was well written and contained useful installation, operation, setup, maintenance and trouble shooting information.

Mechanical Problems: The threads on the bolts, used to tighten the shock mounting plates in position, stripped. Holes were drilled through the gauge wheel arms so bolts could be used to ensure proper tightening of the shock mounting plates.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Relocating the manual override toggle switch for easier access.
2. Modifications to the gauge wheel arms to ensure proper tightening of the shock mounting plates.

Manager/Senior Engineer: E. H. Wiens
Project Technologist: G. Magyar

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Future units will be manufactured with the manual override switch relocated to the front of the controller.
2. This problem was identified at an early stage of production. A change was made so that the bolts tighten into insert nuts instead of tapped holes in the wheel tube.

MANUFACTURER'S ADDITIONAL COMMENTS

1. To minimize soil build up on the tires, the inflation pressure of 8 psi is important. This will allow the tread to flex from a concave to a convex profile during each rotation of the wheel. The action tends to be self cleaning, although we accept that there may be extreme soil conditions which prevent this action.
2. When working fields with extremely unlevel land we recommend that the positioning of the sensor wheels be changed to improve working performance in such situations. The report appears to indicate that the wheels were mounted on the front frame of the cultivator, which would certainly impair the abilities of the system to compensate for these rapid changes in ground level.

GENERAL DESCRIPTION

The Depth Master automatic depth control system is an electronically controlled, hydraulic system intended for maintaining constant implement depth in varying field conditions.

The depth control system consists of an electronic control console mounted in the tractor cab, an electro-hydraulic solenoid valve mounted between the tractor hydraulic remote valve and the implement and three gauge wheels mounted on the implement.

The electronic control console contains function knobs which include "equipment setup", "sensitivity", "dampening", "auto depth", "display zeroing", and "lift rate." Rate of implement raising and lowering is controlled by two adjustment screws. "On-off" power and "auto depth-lift" modes are selected by push button switches. A manual override toggle switch was located on the back panel. An oil temperature warning light and audible alarm are provided as optional equipment. A digital readout displays implement depth.

The electro-hydraulic solenoid valve is pilot operated and electrically controlled. The two inlet ports are connected to the tractor hydraulic remote lines while the two outlet ports are connected to the implement depth cylinders. The Depth Master automatic depth control system can be used on tractors equipped with either open or closed center hydraulic systems.

The Depth Master depth sensors consist of gauge wheels mounted on trailing arms. A potentiometer measures changes in the angle between the trailing arm and the implement frame as the implement depth changes. Each sensor is equipped with a compression spring to apply adjustable ground force and act as a shock absorber for dampening. The sensors are mounted to the implement frame with U-bolts supplied, to accommodate square tubing ranging in size from 3 to 4 in (75 to 102 mm). The sensors are designed for use on implements with frame heights ranging from 26

to 36 in (660 to 914 mm). The Depth Master is powered by the tractor electrical system.

FIGURE 1 shows the major components while detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Depth Master was operated in the field conditions shown in TABLE 1 for about 127 hours. The depth control unit was mounted on John Deere and Case four-wheel drive tractors. The implements used during the testing were a John Deere 665 air seeder and a Blanchard 5-way air seeder. The Depth Master was evaluated for ease of installation, adjustment, operation, safety and reliability. Measurements were taken and observations were made to determine the effectiveness of the depth control system in maintaining uniform implement depth in typical prairie conditions.

TABLE 1. Operating Conditions

CROP	FIELD TILLAGE CONDITION	FIELD AREA		HOURS
		ac	ha	
Fertilizer Banding	Stubble - Primary	1260	510	45
Spring Wheat	Stubble - Secondary	510	206	17
Spring Wheat	Summerfallow - Secondary	700	283	25
Durum Wheat	Stubble - Primary	600	243	23
Durum Wheat	Stubble - Secondary	400	162	17
TOTAL		3470	1404	127

RESULTS AND DISCUSSION

EASE OF INSTALLATION

The Depth Master automatic depth control system was easily installed. FIGURE 2 shows installation of the depth control console in the cab of a Case 4694 tractor. Two holes had to be drilled in the tractor cab to mount the console.

FIGURE 2. Depth Master Control Console.

A bracket was fabricated to mount the electro-hydraulic solenoid valve on the rear frame member of the Case 4694 tractor (FIGURE 3). The valve could also be mounted on the implement hitch. Hydraulic fittings, hoses and quick couplers were purchased to connect the valve to the tractor hydraulics.

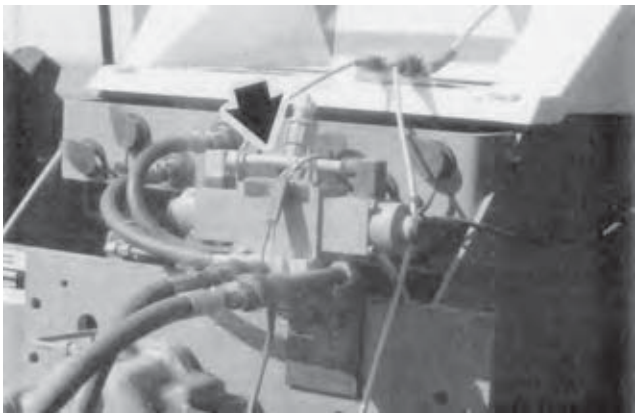

FIGURE 3. Electro-Hydraulic Solenoid Valve Mounted at Rear of Tractor.

The Depth Master gauge wheels were easily mounted on the front frame member of the cultivator used during the test (FIGURE 4). One gauge wheel was mounted on each of the three sections of the cultivator. Electrical cables were strapped to the implement frame and hitch using plastic cable ties.

Installation of the control console, electro-hydraulic valve and three depth gauge wheels took one man approximately four hours.

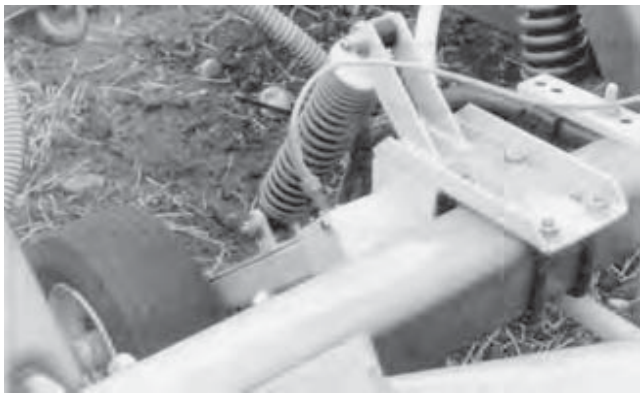

FIGURE 4. Depth Master Gauge Wheel Mounted on Cultivator Frame.

QUALITY OF WORK

Seed Placement Accuracy: The Depth Master depth control system was used predominantly for controlling cultivator depth during normal spring seeding with an air seeder.

In addition to using the Depth Master in normal air seeder operation, special field plots were prepared for the purpose of determining controller effectiveness. The test plot preparation work consisted of preworking a number of strips across a summerfallow field with a cultivator to different depths. This resulted in a variation in field firmness when seeding along the field. Seed depth desired for both test plot and field work was 2.0 to 2.5 in (50 to 63 mm).

Depth control effectiveness was determined both by observing its performance during normal field operation and by comparing seed depth placement in adjacent strips seeded with and without the controller. Seed depth placement was determined by uprooting plants after they emerged and measuring the distance between the seed and the point where the plant emerged through the soil surface. Seed depth measurements were taken across the width of the machine and along the seed rows, both in test plots and in various fields.

Seed placement measurements in firm conditions showed little difference between average seed depth placement when seeding with and without the depth control system. When soil conditions varied from soft to very firm, the depth control system was effective in maintaining a more uniform seed placement depth. For example, without the depth control system, average seeding depth increases of almost an inch (25 mm) were experienced due to the cultivator penetrating deeper in soft conditions. When using the depth control system, little change in average seeding depth was observed.

Response: Response of the Depth Master depth control system could be adjusted by the “dampening” and “sensitivity” control knobs. Proper adjustments were important to ensure response to changes in depth did not occur too frequently or too infrequently for the prevailing soil conditions. The “dampening” knob controlled the amount of time over which sensor outputs were averaged. An increase in dampening increased the time between controller depth corrections. The sensitivity knob adjusted the speed of response of the cultivator to changes in sensor depth. An increase in sensitivity resulted in a faster response when a depth correction was required. The depth control system response could be adequately adjusted for all field conditions encountered during the test.

Field Variables: Overall best performance with the Depth Master was obtained in fields which had not been previously tilled or on previously tilled fields which had been worked in a different direction or had been harrowed and packed. When working unpacked fields in the same direction as the previous operation, implement depth was subject to any surface ridges. For example, when one or more of the gauge wheels travelled along a surface ridge, the depth control system would adjust the implement to reflect the new depth readout. This readout would not be correct for the total width of the

implement.

The effect of surface ridges on depth control could be reduced by travelling across surface ridges at an angle to the previous pass. Also, if the centre gauge wheel could be mounted on the rear frame member of the cultivator, so it travelled on tilled ground, the effect of surface ridging could be reduced. With both of the above approaches, the depth control unit when averaging the readings from the three gauge wheels, provided for improved depth control.

In hard field areas, such as those caused by extensive field traffic, uneven implement penetration occurred. This was evident in areas where one section of the implement encountered a very hard area while the remaining section(s) did not. Due to poor penetration of the implement section in the hard area, the depth control system would want to lower the implement, allowing the remaining implement section(s), which were on softer ground, to penetrate too deep.

In moist conditions, soil would build up on the gauge wheels, resulting in erroneous depth readings.

Due to cultivator frame geometry, the depth control system was not effective in maintaining a uniform depth of tillage when going through gullies or over sharp hill crests.

EASE OF OPERATION AND ADJUSTMENT

Calibration: An experienced operator could calibrate the control console in less than five minutes. Control console calibration involved adjusting the “equipment set-up” control in conjunction with the sensor wheels to establish a ground level reference. The “auto-depth” control was used to set the desired working depth to be maintained or controlled. The “display zeroing’’ knob was used to zero the display when the implement was at ground’ level, so actual average implement working depth would be displayed.

In the initial setup, the rate screws required setting to ensure that the “up rate” of the implement would equal the “down rate.” This adjustment required repeating only if the depth control system was put onto a new implement.

Depth Adjustment: To change the desired depth simply required changing the “auto depth” control to a new desired working depth.

Manual Override: If the control console malfunctioned, the operator could still raise or lower the implement by using the manual toggle switch. The power switch on the control console had to be in the “off” position for the toggle switch to work. The toggle switch was located at the rear of the console. This was felt to be inconvenient. It is recommended that the manufacturer consider repositioning the manual override switch to allow for easier access.

Hydraulics: The Depth Master automatic depth control unit could be used on tractors equipped with either open or closed center hydraulic systems. The maximum flow capacity of the solenoid valve was 25 gal/min (114 L/min).

Visibility: The automatic depth controller was considered advantageous for use with air seeders where visibility of the cultivator was obstructed by the grain tanks. The depth control system provided the operator with an indication of seeding depth.

OPERATOR SAFETY

The Depth Master automatic depth control system was considered safe for field and transport use providing adequate precautions were taken. Caution should be used to avoid working under the implement without a safety lockup in place. A safety lockup should also be used to ensure safe transport.

OPERATOR’S MANUAL

The operator’s manual for the Depth Master automatic depth control system contained useful information on components, installation, setup, maintenance and trouble shooting. The manual was easy to follow and contained good, step-bystep setup and operating instructions.

MECHANICAL PROBLEMS

The Depth Master automatic depth control system was operated in the field for about 127 hours. The intent of the test was functional performance and an extended durability evaluation was not conducted. TABLE 2 outlines the failures that occurred during functional testing.

TABLE 2. Mechanical History

ITEM	OPERATING HOURS
bolts holding shock mounting plate in position would not tighten properly	5

The threads stripped on the bolts used to tighten the shock mounting plates in position. All three gauge wheel arms were modified by drilling holes through the arms so the shock mounting plates could be tightened by the use of a nut and bolt (FIGURE 5). No further problems occurred. It is recommended that the manufacturer consider modifications to the gauge wheel arms to allow proper tightening of the shock mounting plates.

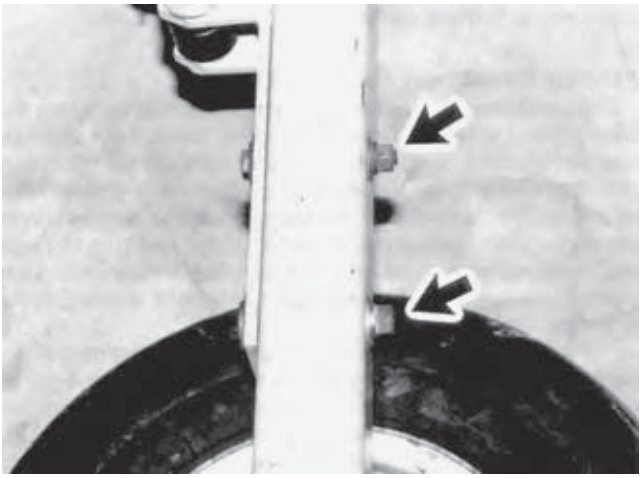

FIGURE 5. Bolt and Nut Holding Shock Mounting Plate in Position.

APPENDIX I

SPECIFICATIONS

MAKE:	Depth Master
MODEL:	DCUI
SERIAL NUMBER:	8304MJ 0496
MANUFACTURER:	Inventronics Sask. Ltd. Box 1750 1955 Caribou Street Moose Jaw, Saskatchewan S6H 7K8

CONTROL CONSOLE:

- width	12 in (305 mm)
- length	10 in (254 mm)
- height	3.75 in (95 mm)
- weight	4 lb (1.8 kg)
- mounting	hanging bracket
- power supply	12 volt negative ground

GAUGE WHEELS:

- tire pressure	8 psi
- height adjustment	26 to 36 in (660 to 914 mm)
- mounting	two U-bolts

ELECTRO-HYDRAULIC VALVE:

- make	Rexroth
- model	4WRA 10
- manufacturer	Rexroth Worldwide Hydraulics 2315 City Line Road Bethlehem, PA 18018
- width	2.75 in (70 mm)
- length	12.3 in (312 mm)
- height	4.75 in (121 mm)
- solenoid	12 VDC
- pressure	3500 psi (24115 kPa)
- weight	22 lb (10 kg)
- mounting	subplate 2 - 3/8 in (9 mm) bolts
- plumbing	3/4 in (19 mm) NPT

APPENDIX II

MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

Excellent	Fair
Very Good	Poor
Good	Unsatisfactory

APPENDIX III

CONVERSION TABLE

acres (ac) x 0.40	= hectares (ha)
gallons (gal) x 4.55	= litres (L)
horsepower (hp) x 0.75	= kilowatts (kW)
inches (in) x 25.4	= millimetres (mm)
miles/hour (mph) x 1.61	= kilometers/hour (km/h)
pounds (lb) x 0.45	= kilograms (kg)

SUMMARY CHART
DEPTH MASTER AUTOMATIC DEPTH CONTROL SYSTEM

RETAIL PRICE:	$2750.00 (March. 1986, f.o.b. Lethbridge)
QUALITY OF WORK:	
-- seed placement accuracy	- a more uniform depth of seed placement resulted when using the depth control unit in varying soil conditions. - did not improve seed placement within uniform soil conditions.
-- response	- acceptable for all types of conditions encountered.
-- field variables	- inadequate depth control when travelling parallel to surface ridges or when penetration uneven across width of implement. - inadequate depth control when travelling through gullies or over sharp hill crests.
EASE OF OPERATION AND ADJUSTMENT:	
-- calibration	- experienced operator could calibrate in less than five minutes.
-- depth adjustment	- changing “auto depth” function knob to new setting.
MANUAL OVERRIDE:	- raise or lower implement if control console was not working.
HYDRAULICS:	- could be used on either open or closed hydraulic systems.
VISIBILITY:	- provided indication of tillage depth when implement view was obstructed.
OPERATOR SAFETY:	- safe - implement safety lock-ups should be used for transport.
OPERATOR’S MANUAL:	- easy to follow - contained useful information.

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