Alberta Farm Machinery
Research Centre

Printed: March, 1989
Tested at: Humboldt
ISSN 0383-3445
Group 4c

Evaluation Report 591

Crary Finger Air Reel

A Co-operative Program Between
ALBERTA FARM MACHINERY RESEARCH CENTRE
PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

CRARY FINGER AIR REEL

MANUFACTURER:

Crary Company
P.O. Box 1779
Fargo, North Dakota 58107
U.S.A
Telephone: (701) 282-5520

DISTRIBUTOR:

Appolo Distributing Corporation
P.O. Box 528
White City, Saskatchewan
S0G 5B0
Telephone: (306) 781-2644

RETAIL PRICE:

$6075.00 [March, 1989, f.o.b. Humboldt, Saskatchewan, for fan assembly, 24 ft (7.3 m) manifold, pickup reel and mounting hardware.]

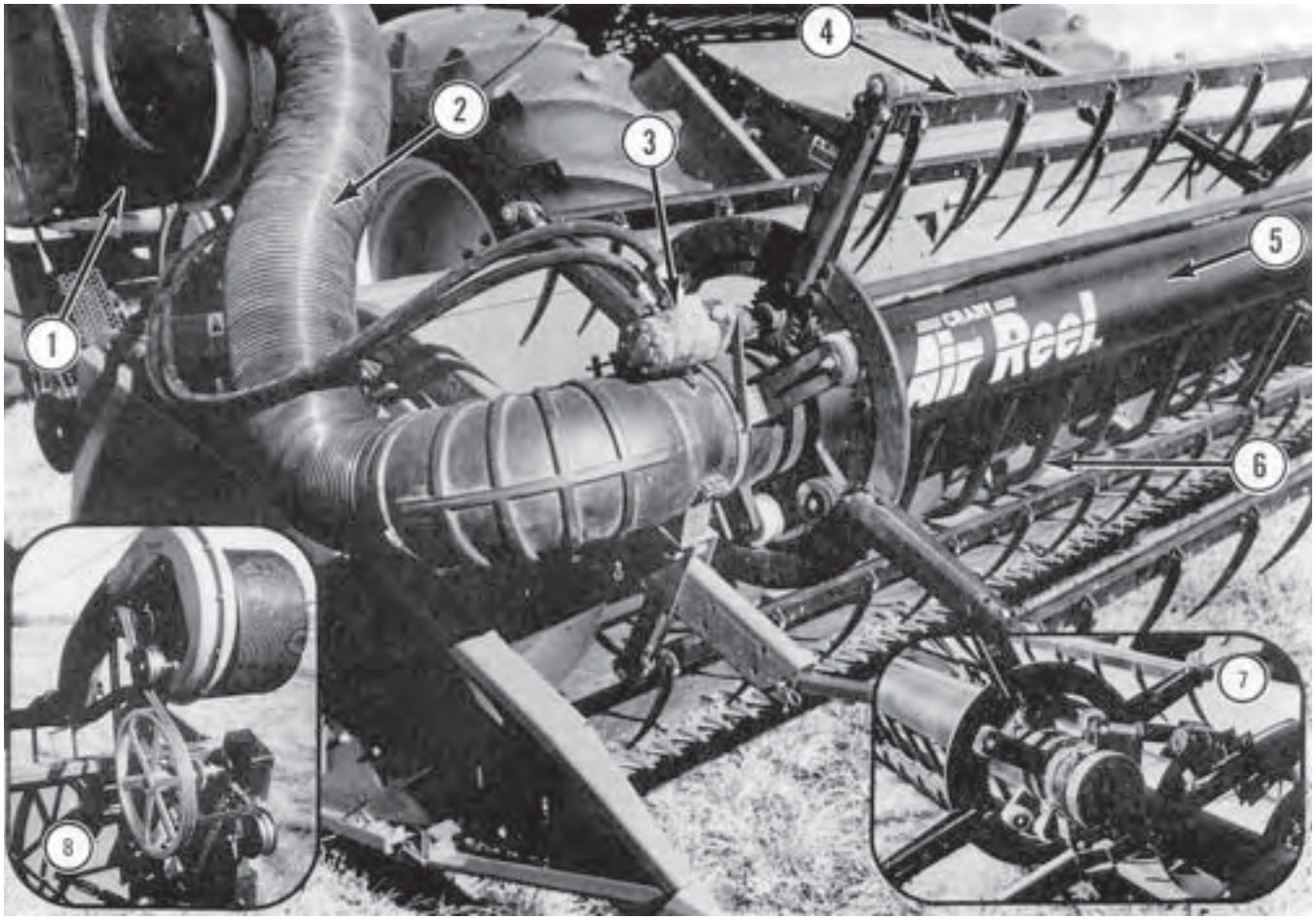

FIGURE 1. Crary Finger Air Reel: (1) Fan, (2) Flexible Duct, (3) Reel Drive, (4) Reel Bat with Pickup Fingers, (5) Manifold, (6) Nozzles, (7) Nozzle Tilt Actuator, (8) Fan Drive.

SUMMARY AND CONCLUSIONS

Rate of Work: The rate of work for the Crary Finger Air Reel was very good in all conditions encountered, the reel maintained smooth positive crop flow and did not limit feedrate.

Quality of Work: The Finger Air Reel provided very good air delivery to the crop. The volume and velocity were adequate and the distribution uniform. Crop movement was very good. The air plus mechanical actions provided smooth positive movement in all crop conditions encountered. Shatter loss and head loss were similar to those of a bat reel in average and taller crops. The Finger Air Reel was much better adapted to operation in very short crop and lodged crop than a bat reel.

Ease of Operation and Adjustment: The ease of installation was good. The special split pulley and modified key made it unnecessary to remove the header shaft for installing the fan drive, Ease of adjustment was very good. Air discharge direction, fan blast, reel height and reel speed were all adjustable from the cab.

Ease of setting the reel to work in various crop conditions was very good. The combined mechanical and air action provided a wide range of suitable adjustment. Visibility was very good in most conditions. Ease of maintenance was very good.

Power Requirements: The fan required up to 25.0 hp (18.7 kW). The extra torque required on start-up made it necessary to engage the header before the separator to avoid slipping the clutch on the header shaft driving the fan. Once up to speed, no problems were encountered. The power required by the fan did not noticeably affect the performance of the combine used in these tests.

Operator's Manual: No operator's manual was available at the time of testing.

Operator Safety: No safety problems were encountered but normal caution was required.

Mechanical History: A weld on the jackshaft mounting assembly failed and a guide roller stand bent.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to improve the ease of reel motor drive alignment.
2. Modifications to the fan drive tightener to provide more

convenient belt removal.
3. Supplying an operator's manual.

Senior Engineer: J. D. Wassermann

Project Manager: L. G. Hill

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Crary is now providing a redesigned reel motor mount. A hydraulic motor is now also being provided, instead of adapting the existing reel motor.
2. Crary has redesigned this belt tightener. All units now have the new tightener.
3. Crary now has an operator's manual complete with parts information and installation pictures. (It had not been completed during the PAMI tests).

GENERAL DESCRIPTION

The Crary Finger Air Reel (FIGURE 1) uses both rotating bats and jets of air to feed crop to a combine direct cut header. The rotating bats and jets of air force the crop back toward the header while the cutterbar moves through the crop. The bats and air then transport the cut crop to the combine table auger.

The air is supplied by a centrifugal fan ducted to a tubular manifold, which spans the width of the cutterbar. Vertical "drop" tubes (nozzles) spaced along the manifold direct jets of air at the crop. A hydraulic motor rotates the pickup reel bats about the manifold.

The fan is located above and slightly behind the end of the header. It is belt driven from an existing header drive shaft and runs at a fixed speed. Air volume is controlled by an adjustable damper in the fan exhaust outlet. The reel is mounted on the header reel arms. Fore-and-aft positioning is set manually by screw actuators. Vertical reel height position is adjusted on-the-go from the cab using the combine's reel height controller. An electric actuator, controlled from the cab, rotates the manifold to change the direction of the air blast from the nozzle. The pickup reel is hydraulically driven and the speed is controlled by the combine's normal reel speed controller. The pickup tooth angle may be set manually by rotating the eccentric rings.

Detailed specifications are given in APPENDIX 1.

SCOPE OF TEST

The main purpose of the test was to determine the functional performance of the Crary Finger Air Reel. Measurements and observations were made to evaluate the reel for rate of work, quality of work, ease of operation and adjustment, power requirements, operator safety and the suitability of the operator's manual. Although extended durability testing was not done, mechanical failures, which occurred during the test, were recorded.

The reel was mounted on a John Deere 224 direct cut header, which had the cutterbar set in the mid-position. The reel was operated for 28 hours during which 235 acres (95.1 ha) of crop were harvested in various field conditions shown in TABLE 1.

Gathering loss tests were conducted in both wheat and barley. Shatter loss (threshed kernels) and head loss were collected using "nested" pans placed across the width of cut. Several sets of collections were made at a single ground speed, which was typical for the combine. For comparison, similar collections were made under the same conditions at the same speed using a bat reel.

In the lab, tests were conducted to determine fan performance and also to define the air discharge pattern from the nozzles.

RESULTS AND DISCUSSION

RATE OF WORK

The rate of work for the Crary Finger Air Reel was very good.

The reel did not limit the harvest rate in any conditions encountered.

In short, low yield crops, ground speeds up to 7 mph (11.2 km/h) were possible. However, the demand on the operator to control the header when cutting so close to the ground made prolonged operation impractical. A speed of about 6 mph (9.7 km/h) was much more suitable. This was generally a little faster than practical with a bat reel. In heavier crops, speed was limited by combine capacity and the header's conveying ability. Speeds were similar to those attained when using the bat reel. However, in lodged and tangled crop, the Finger Air Reel was able to keep the combine cutting faster and at a more uniform rate than with the bat reel.

QUALITY OF WORK

Air Delivery: Air delivery was very good.

Air was supplied by a Crary centrifugal fan. The fan typically delivered about 2000 cfm (940 L/s) of air with the fan damper fully open. The static pressure in the manifold ranged from about 28.5 to 31.0 in•wg (7100 to 7720 Pa). The static pressure in the nozzle tubes varied only by about 7% from the average. This small difference in static pressure between the nozzles suggested fairly uniform airflow along the length of the manifold.

The air discharge pattern from the nozzles is shown by the smoke patterns in FIGURES 2 and 3. FIGURE 2 shows that, viewed from above, each nozzle discharged air in a "fan" shaped pattern. The air discharge was nearly uniform across the fan pattern. The outer edge of the air pattern met air from adjacent nozzles about 8 to 10 in (203 to 254 mm) behind the nozzles and formed a uniform pattern. The side view, (FIGURE 3), shows that the air blast from the nozzles was not very deep. The air spread to only about 4 in (102 mm) after it travelled about 12 in (305 mm). It dispersed quite rapidly after that, but remained fairly distinct to about 24 in (610 mm) behind the nozzles.

Although the lab test showed a slight variation in the airflow across each discharge pattern, field observations indicated that the pattern uniformity was appropriate for even crop feeding.

Only a small amount of chaff ever collected on the fan inlet screen, and at no time did it cause any noticeable effect on airflow.

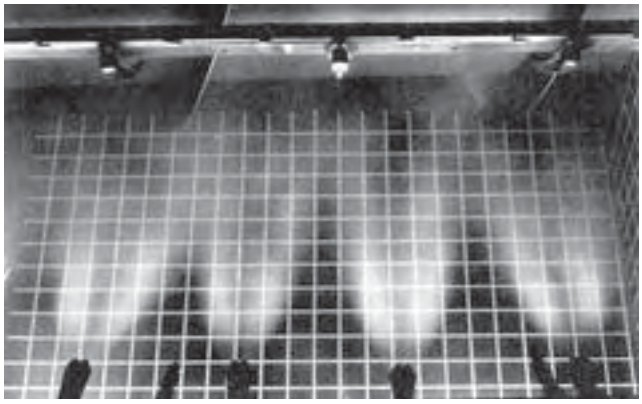

FIGURE 2. Top View of the Nozzle Discharge Pattern.

Crop Movement: Crop movement was very good.

When straight combining, a reel performs several functions critical to proper crop movement into the combine. First, it must hold the crop so that the cutterbar can move through the crop and cut the stalks. Next, it must ensure that the crop is moved back to the table auger correctly for proper conveying and feeding. In taller crops, the material should be transported vertically along the front of the table auger. The reel must prevent plants from falling forward which is especially important at the center where the crop accumulates before being fed under the auger. In shorter crops, the material is normally conveyed under the auger rather than in front of the auger.

TABLE 1. Operating Conditions

Crop	Variety	Yield Range		Crop Height		Field Area		Crop Harvested		Hours
		bu/ac	t/ha	in	mm	ac	ha	bu	t	
Barley	Harrington	55-60	3.0-3.2	12-24	305-610	45	18.2	2460	53.7	6.5
Mustard	Gisilba	10-20	0.6-1.1	15-36	381-914	95	38.4	1700	38.6	13.0
Wheat	Katepwa	10-40	0.7-2.7	10-40	254-1016	95	38.4	2540	69.3	8.5
Total						235	95.1	6700	161.6	28.0

The reel must direct the plants to fall headfirst into the auger. This is required to ensure headfirst conveying to the feeder. However, once under the auger there is a natural tendency for crop to spiral with the auger. To prevent this, most headers are equipped with “auger strippers”. This is an adjustable metal strip located on the header panel behind the auger. It is set at a minimal clearance to the auger flighting. This strips the crop away from the auger forcing the auger to convey the material to the center.

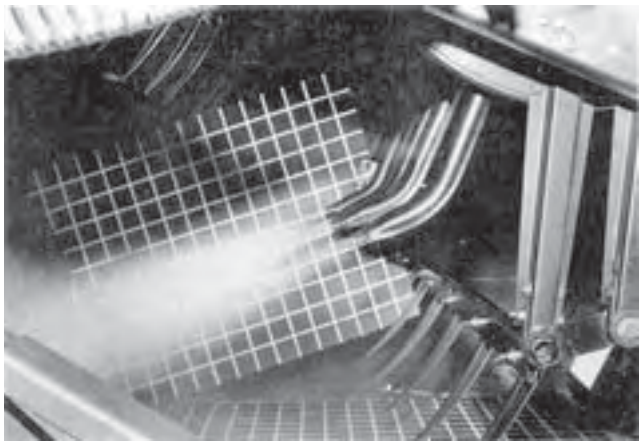

FIGURE 3. Side View of the Nozzle Discharge Pattern.

The Crary Finger Air Reel, when properly adjusted, provided suitable crop movement in all conditions encountered. The reel provided a combination of reel finger lifting action, positive force of the rotating bats plus the constant force of the air blast. In average and tall crops, at least 20 in (508 mm) tall, the bats and air held the crop for effective cutting and kept the crop travelling smoothly along the front of the auger (FIGURE 4). At the center, the crop was pulled under the auger and fed headfirst into the feeder.

In down, lodged and tangled crop, the lifting action and positive rearward force of the reel fingers and bats, along with the air, prevented the cutterbar from plugging and provided smooth conveying and feeding.

FIGURE 4. Smooth Crop Flow Along Table Auger.

In shorter crops, 10 to 15 in (250 to 380 mm) tall, the air blast was more effective than the reel. The air blast held the crop while being cut then moved the crop smoothly over the cutterbar. However, since the crop was very short, it was conveyed under the table auger (FIGURE 5). Once under the table auger, the typical tendency of an auger to carry material around with it resulted in most of the crop being conveyed behind the auger against the “auger stripper”. On this header, the “auger stripper” often did not hold the crop. Towards the center of the header where more material was being conveyed crop was carried around the auger and thrown forward onto the ground. The air blast had little to do with the carry over and it is possible that this behavior was unique to this one header. To keep the crop contained, a second stripper was added. A small angle was bolted to the auger trough floor, just slightly behind the auger’s vertical centerline. This “floor stripper” greatly improved this header’s crop conveying in the short crops encountered.

FIGURE 5. Air Providing Smooth Feeding in Short Crop.

Gathering Loss: Gathering loss is made up of loose kernels and heads, which are lost during the gathering process. The loose grain is called shatter loss and is grain threshed by contact with the reel, table auger or auger fingers, and/or by the vibration created by cutting and crop movement. Head loss consists of whole or part heads which fall to the ground. These heads may be lost because the heads have dropped into the crop due to weakened straw and the cutterbar cuts above them. Alternatively, the heads may be just above the cutterbar and fall off the cutterbar as soon as they are cut. As well some heads may be thrown forward by the auger or auger fingers.

When comparing two different reels it would be beneficial to be able to compare the loss from each reel. However, it is nearly impossible to collect only the loss that each reel caused. A more practical method is to compare the gathering loss from the same header alternately equipped with each reel and tested under similar conditions. Since the other components are the same, any differences in gathering loss can be attributed to the reels.

The wheat and barley crops, used for the loss test, were mature, dry, and of an average stand. The combine was operated at about 3.0 mph (4.8 km/h) in the barley and about 3.5 mph (5.6 km/h) in the wheat. Shatter loss when using the Finger Air Reel was low. In barley, shatter loss was less than 0.5% of the yield and in wheat less than 0.3% of yield. These losses were nearly identical to those of the bat reel. Harvesting at slightly higher moistures would likely have even further reduced the shatter loss. Head loss was about 2 to 2.5% of the yield in both wheat and barley, which was nearly identical to the head loss for the bat reel. Again, harvesting at higher moisture before the heads had settled into the crop would likely have greatly reduced the head loss.

Although gathering loss for the Crary Finger Air Reel was not significantly different than the bat reel in average crop conditions, different results could occur in other crop conditions. However, there are simply too many combinations of speed, equipment selection and crop conditions to provide a complete comparison. Nevertheless, general observations were used to qualitatively assess losses in more extreme conditions. In short crop, the constant air blast continually moved heads and short crop over the cutterbar and into the auger. With some headers the reel may not have been able to clean the cutterbar. Crop would have dropped onto the cutterbar with a large percentage falling to the ground. Whereas with the Finger Air Reel, very little crop fell off the cutterbar. In lodged crop, the lifting action of the fingers enabled cutting beneath the crop mat, saving more heads while cutting faster.

EASE OF OPERATION AND ADJUSTMENT

Installation: Ease of installation was good.

It took two people about five hours to mount the Finger Air Reel on a John Deere 224 direct cut header. The fan assembly was mounted on the right end of the header (FIGURE 1). The main bracket was welded to the top beam of the header. The support tensioning brackets were bolted to the back header panel. The manufacturer supplied a special pulley and key so that the header shaft did not have to be removed. A keyway was ground into the shaft with a hand grinder and the two halves of the pulley were slipped over the shaft and bolted together. Care was required to

ensure belt alignment.

The manifold and reel were supplied fully assembled. Mounting the reel on the reel arms was fairly easy; however, the reel was too heavy to lift by hand so a hoisting mechanism was required. The flexible duct was fairly easy to install although it was hard to get over the insert, which joined it to the elbow. The reel drive motor mounting bracket had to be shimmed to align the motor to the shaft. A flexible coupling or motor mount would have improved the ease of mounting. It is recommended that the manufacturer consider modifications to improve the ease of reel motor drive alignment.

The nozzle angle controller was easy to wire in and the fan damper control was easy to install.

Adjustment: Ease of adjustment was very good.

The manufacturer's brackets provided easy fore-and-aft adjustment using screw actuators. Nozzle angle adjustment was changed by an electric actuator controlled from the cab and was easily adjusted on-the-go. Reel bat finger angle was adjusted by rotating the reel eccentric rings. This was somewhat inconvenient but change was seldom required once set.

A push-pull control permitted adjusting the fan damper on-the-go from within the cab. However, it was fairly stiff to operate when the fan was running. Reel height and reel speed adjustment were easy using the combine's reel controls.

Field Setting: Ease of setting for crop condition was very good.

Although there was no operator's manual available at test time, setting was not difficult as setting changes provided very noticeable differences in performance. Setting by experimenting with speed, height, angle, and air quickly provided feedback for establishing suitable settings. As well, the combination of both mechanical and air action permitted considerable misadjustment of one or the other without adverse effects.

The same basic settings worked well in most crops and conditions (FIGURE 6). The reel was set so that the reel bat touched the top of the crop with the pickup fingers extending down into the crop. The reel speed was set close to or just slightly faster than ground speed, which was slightly slower than typically used by bat reels. The nozzles were tilted to aim just behind the cutterbar and the fan damper set at about half to three quarters open.

FIGURE 6. Typical Setting for Most Crops.

Visibility: The Crary Finger Air Reel enabled very good visibility of the crop, cutting, and crop flow in most crop conditions (FIGURE 7).

In short sparse crop, the constant airflow kept the cutterbar clean, while in all crops the reel bats, manifold, and nozzles obstructed the operator's view very little. The air blast stirred up more chaff and dust than a bat reel. This was not a problem except in the dim light between sunset and dark. At this time of day, the chaff and dust became more noticeable. The decreased visibility was especially noticeable when operating in short crops where the air was required for crop movement and header height control was critical. During this hour or two, the natural light wasn't adequate to be able to see the ground and cutterbar and the combine lights didn't make an appreciable difference. It was helpful to reduce airflow to as low as practical. Once dark, the combine lights were much more effective. The light penetrated the dust and chaff, visibility was greatly improved, and normal airflow settings could be used.

The Finger Air Reel was less tiring to operate, especially at night, than a bat reel because the reel bats were much smaller and reflected less light back at the operator.

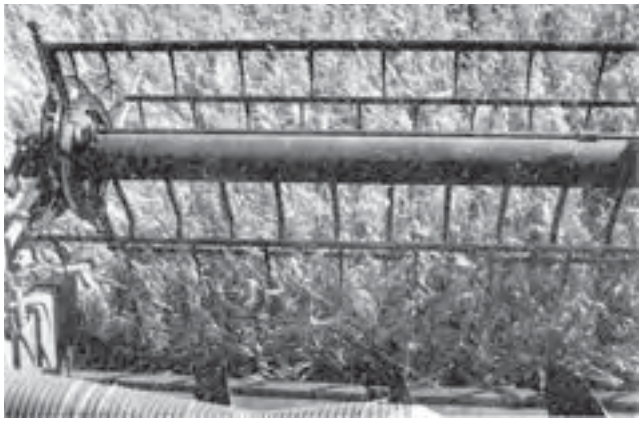

FIGURE 7. Clear Visibility.

Maintenance: Ease of routine maintenance was very good.

Very little maintenance was required. The fan drive used spring loaded idlers while the jackshaft bearings required infrequent lubrication. Fan belt removal was inconvenient due to the tensioning idlers pivot being located such that the idler could not be pulled away from the belt. It is recommended that the manufacturer consider modifications to the fan drive tightener to permit more convenient belt removal.

The reel required only routine inspection to ensure that the ring guides stayed in alignment and that all couplers were secure.

POWER REQUIREMENTS

Power requirements for the Crary fan ranged from about 17.5 hp (13 kW) with the damper closed to about 25.0 hp (18.7 kW) with the damper open. The fan drive handled the load without any problems. However, on start-up the power demand of the fan caused the clutch on the header drive shaft to slip. This was overcome by engaging the header drive before engaging the main combine drive. Once up to operating speed no adverse effects on combine performance were noticed.

The power required was much higher than the power required by the bat reel. On combines, which operate near their power limit, the extra power required to run the fan may cause a noticeable reduction in the feedrates normally attained.

OPERATOR'S MANUAL

An operator's manual was not available at the time of testing. It is recommended that the manufacturer consider supplying an operator's manual.

OPERATOR SAFETY

The Crary Finger Air Reel did not present any safety problems. The fan was well shielded and there was one decal under a shield, which warned not to operate without the shields in place.

As with most reels with rotating bats, there is an inherent danger if fundamental precautions are not taken. Anytime when working near the header it is vitally important to disengage all drives and shut off the engine. The header should be lowered to the ground or securely blocked.

MECHANICAL HISTORY

The intent of the test was evaluation of functional performance. Extended durability testing was not conducted. However, TABLE 2 outlines the mechanical history of the Crary Finger Air Reel during the test.

TABLE 2. Mechanical History

Item	Operating Hours	Equivalent Field Area	
		ac	(ha)
-a reel support ring guide roller deformed and was straightened at	13.5	90	(36.4)
-a weld on the fan mounting bracket failed and was repaired at	end of test		

Support Bending: The support probably bent due to contact between the roller retaining bolt and the reel bat arms (FIGURE 8) as clearance was minimal. The support was easily bent back to its original position.

FIGURE 8. Deformed Guide Support.

Weld Failure: The weld failure on the fan support (FIGURE 9) was due to a poor quality weld. Proper welding procedure and quality control would prevent similar failures. It should be noted that the same fan was used in the Crary Air Reel test as reported on in PAMI Report #590. This is the same failure, which was described in that report, not another similar failure.

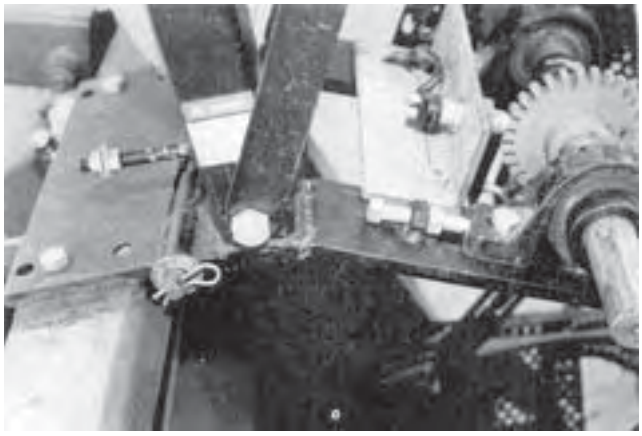

FIGURE 9. Weld Failure.

APPENDIX I
SPECIFICATIONS

MAKE:	Crary
MODEL:	Finger Air Reel - 24 ft (7.4 m)
FAN:	
-- type	Centrifugal - “squirrel cage”
-- number of blades	48
-- outside diameter	16.4 in (416 mm)
-- inlet diameter	14.3 in (362 mm)
-- outlet diameter	7.4 in (188 mm)
-- operating speed	run at 4200 rpm (maximum 4600 rpm)
-- damper control	lockable control cable from cab
-- drive	2 stage v-belt 3 “b” belts from header shaft to jackshaft 2 “b” belts from jackshaft to fan
MANIFOLD:	
-- material	steel
-- thickness	0.08 in (2 mm)
-- cross section shape	8” (203 mm) round, single section tube
-- length	24.6 ft (7.5 m)
-- inlet diameter	8 in (203 mm)
-- angle adjust	electric actuator
NOZZLES:	
-- type	single, curved steel tube with crimped outlet
-- angle of curve	138°
-- number	28
-- length	16 in (406 mm) [optional 17 in (432 mm)]
-- diameter	1.25 in (32 mm)
COUPLER:	
-- type	flexible vinyl tube with spiral steel reinforcing wire
-- diameter	8 in (203 mm)
-- length	5 ft (1.5 m)
-- adapter to manifold	molder rubber elbow
-- retainers	bolted steel rings
REEL:	
-- type	4 bat with pickup fingers
-- diameter	44 in (118 mm) to bat. 10 in (254 mm) fingers
-- drive	hydraulic reel motor drives reel gears
WEIGHTS:	
-- fan assembly	180 lb (81.6 kg)
-- reel and manifold	690 lb (313 kg)
OPTIONS:	electric actuator for fan damper control 115° angle of curve on nozzles.

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

Excellent	Fair
Very Good	Poor
Good	Unsatisfactory

SUMMARY CHART
CRARY FINGER AIR REEL

RETAIL PRICE	$6,075.00 (March, 1989, f.o.b. Humboldt, Sask.)
RATE OF WORK	**Very Good;** did not limit combine speed
QUALITY OF WORK	
Air Delivery	**Very Good;** uniform over length of manifold; pattern from each nozzle uniform
Crop Movement	**Very Good;** smooth positive movement in all conditions
Gathering Loss	similar to bat reel in average crops; lower head loss in some lodged crops and in short crop
EASE OF OPERATION AND ADJUSTMENT	
Installation	**Good;** header shaft didn't have to be removed, reel heavy to put in place
Adjustment	**Very Good;** controlled most functions from cab
Field Setting	**Very Good;** appropriate settings were easily determined; once set, suitable for a wide range of conditions
Visibility	**Very Good;** clear view of crop, cutting, and crop movement
Maintenance	**Very Good;** very little service required
POWER REQUIREMENTS	up to 25 hp (18.7 kW)
OPERATOR'S MANUAL	not available at time of test
SAFETY	normal caution required
MECHANICAL HISTORY	a minor weld failure, and a bent support

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