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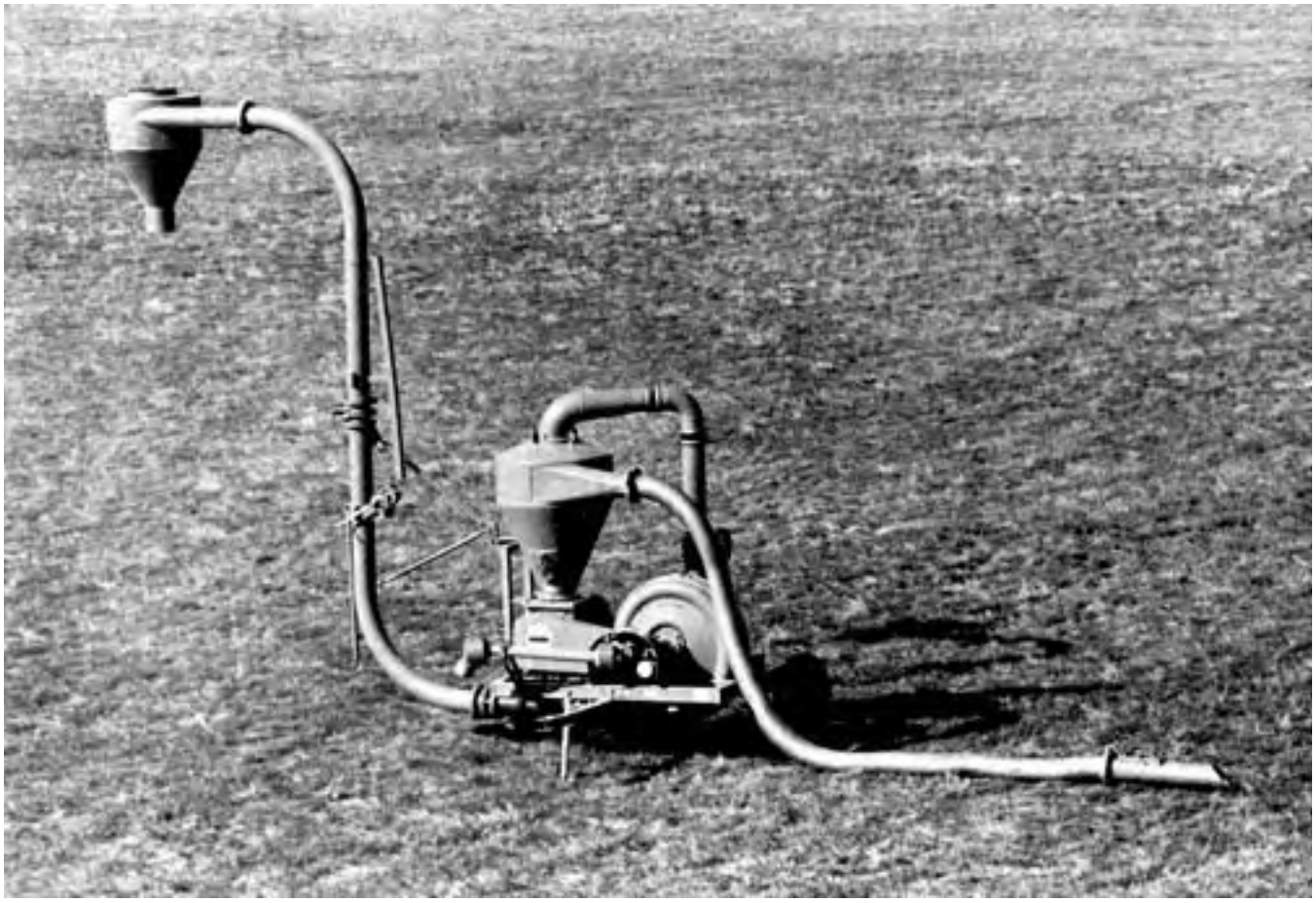
Evaluation Report 133



Neuero 675 Pneumatic Grain Conveyor

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

NEURO MODEL 675 PNEUMATIC GRAIN CONVEYOR

MANUFACTURER:

Neuero Corporation
1201 Hawthorne Lane
West Chicago, Illinois 60185
U.S.A.

RETAIL PRICE:

$14,160 (September, 1979, f.o.b. Lethbridge, complete with mounted truck loading kit with cyclone, 15 feet of 6 inch flex pipe, round nozzle, flat nozzle and heavy mesh cyclone screen).

DISTRIBUTORS:

Crawfords of Alberta
Camrose, Alberta

Lee and Backes, Inc.
Glenburn, North Dakota 5874
U.S.A.

Hyde Park Farm Supply
Hyde Park, Ontario

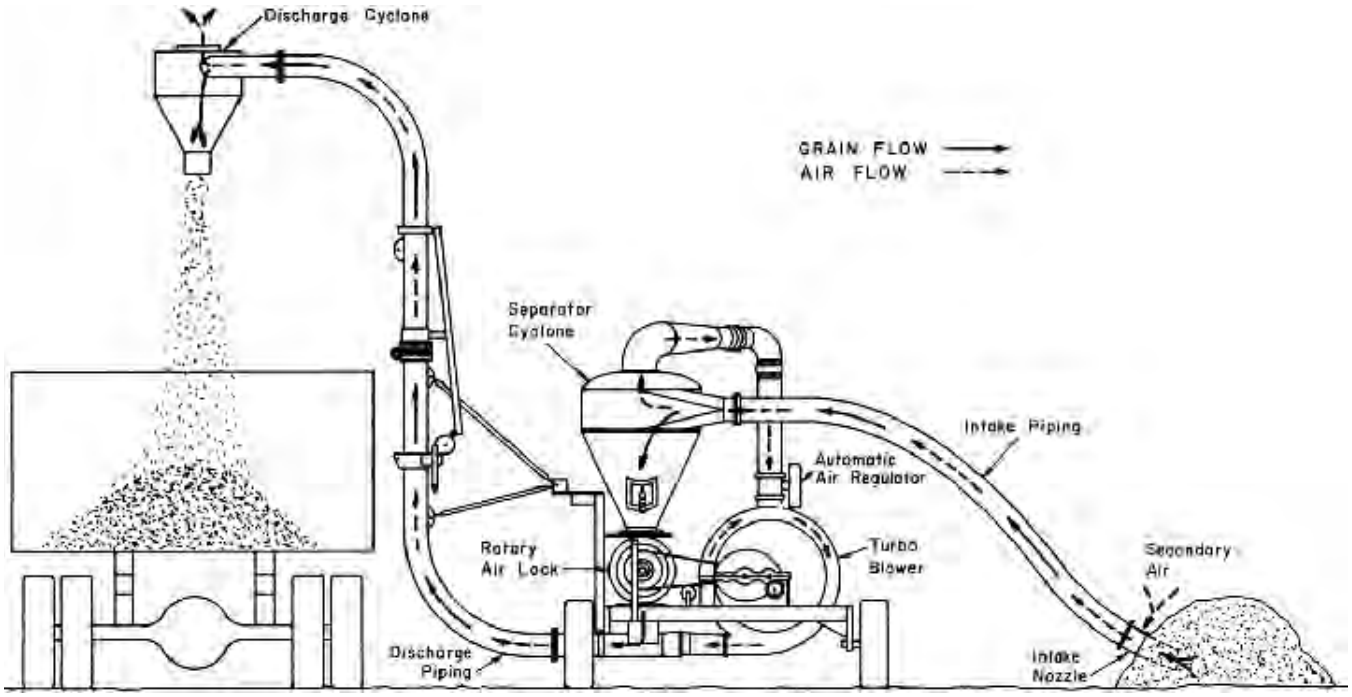


FIGURE 1. Schematic View Showing Air and Grain Flow.

SUMMARY AND CONCLUSIONS

The functional performance of the Neuero model 675 pneumatic grain conveyor was good for conveying wheat, barley and oats. Functional performance was lowered by high power consumption.

The maximum conveying rates obtained were 32.1 t/h (1180 bu/h) for wheat, 36.9 t/h (1696 bu/h) for barley, 34.7 t/h (2250 bu/h) for oats and 27.4 t/h (1208 bu/h) for rapeseed. Conveying rates were reduced significantly when intake or discharge pipe lengths were increased.

Power requirements while conveying grain varied from 25 to 35 kW (34 to 47 hp). A tractor with maximum power take-off output of at least 45 kW (60 hp) was required due to high starting torques.

The specific capacity of an average 7 in (178 mm) diameter grain auger was 5 times greater than that of the Neuero 675 in wheat, 4 times greater in oats and 3.5 times greater in rapeseed, indicating that pneumatic conveying of grain is costly and inefficient when compared to a grain auger.

Crackage in dry wheat was less than 0.2% for each pass through the Neuero 675. This is similar to damage caused by grain auger.

The intake nozzle was fairly easy to maneuver during bin clean-out, but it was usually easier to sweep the grain remaining on a bin floor toward the intake nozzle than to attempt final cleaning with the nozzle. Mounting the discharge cyclone on the standard discharge assembly was easy, but mounting the cyclone on the optional mobile discharge cart was inconvenient.

The Neuero 675 was much safer to use than a grain auger, especially for cleaning grain bins. Working near the inlet nozzle was clean as most dust was conveyed into the inlet. Noise levels adjacent to the conveyor varied from 85 to 98 dBA when operating in open areas. When operating close to metal bins the noise level was loud and irritating. It is recommended that an operator wear suitable ear protection when working, near the Neuro 675.

Several mechanical failures occurred during the test. The hitch clevis bent, the rotary air lock hub wore, the discharge tube cracked and one section of flexible piping cracked.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Supplying a handle to attach to the flexible pipe to facilitate handling of the intake nozzle during bin clean-out.
2. Recalibration of the automatic air regulator so that maximum conveying rates correspond to maximum air regulator readings.
3. Increasing the strength of the hitch clevis.
4. Supplying detailed assembly instructions for the mobile discharge cart.

Chief Engineer: E. 0. Nyborg
Senior Engineer: E. H. Wiens
Project Engineer: M. V. Eliason

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. An optional flex handle is available to facilitate bin cleanout. Also available is a flat nozzle constructed of aluminium to further facilitate bin cleanout.

2. The air regulator is calibrated to offer a compromise for operation in all cereal grains. Conveying velocities are dependent upon many factors such a bulk density, particle size and shape, and line distance and configurations. Consequently, differing air flows are required for changes in applications. The air regulator is designed to function properly for the many variables presented to the machine. In many cases, fine tuning by the operator can generate higher conveying rates. Without this capability, the operator would require a strong grasp of the principles of pneumatic conveying to enable him to set the regulator for each and every material being conveyed.
3. The hitch clevis will most certainly be strengthened if it is determined that this is not an isolated case.
4. Detailed assembly instructions are being drawn up at this time to correct the errors found by PAMI.

MANUFACTURER'S ADDITIONAL COMMENTS

1. The protective inner screen within the primary cyclone has been replaced with a screen having larger holes. This reduces the possibility of plugging and subsequent reduction in conveying rates.
2. The rotary air lock hub and slip clutch have been redesigned, incorporating a bronze bushing to prevent damage to the air lock hub.
3. The discharge tube has been strengthened with a support plate welded to the tube and bolted to the frame. No further problems have occurred since this new method of supporting the discharge tube has been used.
4. Cracking of the flexible piping at the separator cyclone inlet can be avoided by using a 30 or 45 degree elbow to reduce pipe flexing at this point.

GENERAL DESCRIPTION

The Neuero 675 is a 1000 rpm power take-off driven pneumatic grain conveyor, mounted on a two wheel trailer. The turbo blower (Figure 1) provides both suction and discharge air to convey grain without passing it through the blower. Grain is conveyed by the intake airstream through the intake nozzle, through the separator cyclone and into the rotary air lock. It then passes through the air lock into the discharge airstream, which delivers it to the discharge cyclone.

The blower is driven from the power take-off shaft through a gearbox. The rotary air lock is chain driven directly from the gear box. Intake and discharge locations can be varied by adding elbows and sections of rigid and flexible 152 mm diameter pipe. Figure 1 shows the location of major components while detailed specifications are given in Appendix 1.

SCOPE OF TEST

The Neuero 675 was used for 81 hours to convey the various grains and fertilizer shown in TABLE 1.

It was evaluated for ease of operation and adjustment, rate of work, power requirements, quality of work, operator safety, and suitability of the operator's manual.

TABLE 1. Operating Conditions

Material	Quantity Conveyed (t)	Hours
Spring Wheat	463	28
Durum Wheat	283	11
Barley	163	12
Oats	150	14
Rapeseed	27	5
Rye	26	3
Granular Fertilizer	98	8
TOTAL	1210	81

RESULTS AND DISCUSSION

EASE OF OPERATION AND ADJUSTMENT

Standard Discharge: The standard discharge assembly (FIGURE 2) consisted of two hinged 90° elbows, which could be folded for transport. This assembly was designed for conveying grain from a bin to a truck. The 3450 mm discharge height and 1600 mm reach were insufficient for filling grain bins but easily accommodated all common truck box heights.

The discharge cyclone had to be removed and reattached whenever a different configuration of discharge pipe was needed. It should also be removed when transporting long distances or over rough ground. The discharge cyclone weighed 32 kg but one man could easily attach or remove it, using the convenient winch (FIGURE 3) to lower the top section of discharge pipe so the cyclone rested on the ground.

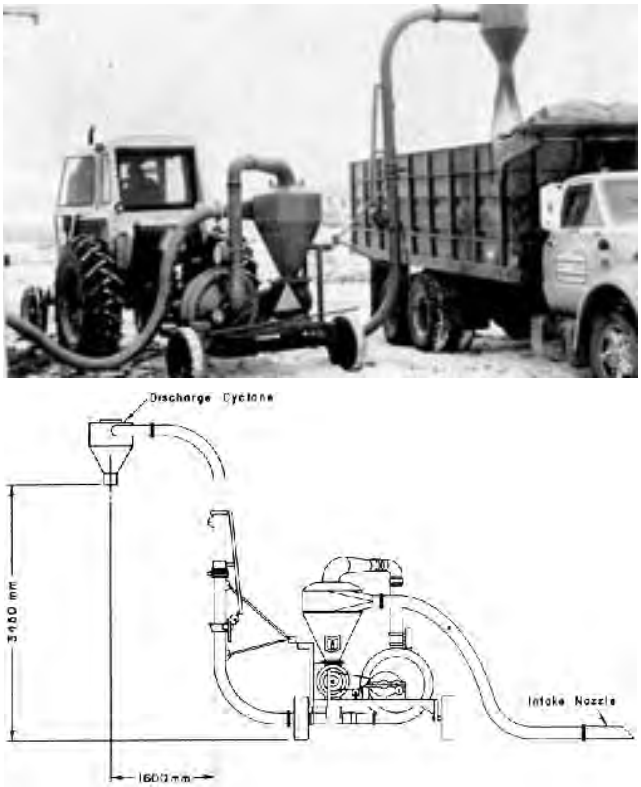


FIGURE 2. Standard Discharge Assembly.

FIGURE 3. Cyclone Resting on Ground for Convenient Attaching: (A) Winch.

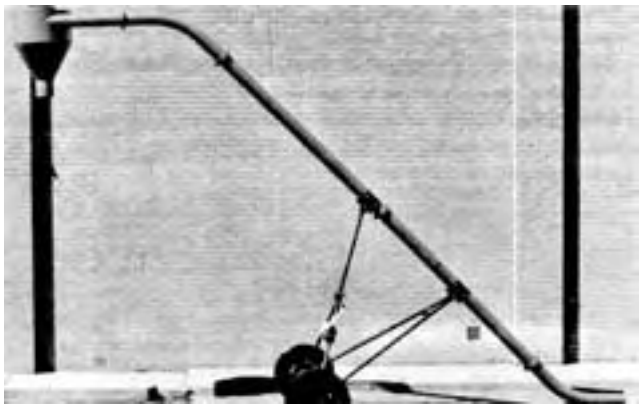
Mobile Discharge Cart: Discharge height and reach changes could be facilitated by using the optional mobile discharge cart (FIGURE 4). The cart provided a discharge height of 3650 mm and a reach of 2550 mm. It was difficult to attach the discharge cyclone to the cart. The cart had to be tilted so the cyclone could be attached on the ground. Due to the weight of the cyclone it was difficult to place the cart back into operating position. A weight was needed on the intake end to keep the cart upright, once the cyclone had been raised.

Initial assembly of the mobile discharge cart was inconvenient since the telescoping brackets had to be positioned by trial and error. An assembly drawing was supplied; however, the correct bracket positions could not be obtained from the drawing. With the brackets positioned as specified on the drawing, the cyclone was not level (FIGURE 5). It is recommended that detailed assembly instructions be supplied.

The supplied towing hitch was easily attached to the cart intake end. The cart towed very well at speeds up to 65 km/h.

Conveying Pipes: Rigid pipe sections were available in 3050

mm lengths while 3050 and 4575 mm lengths of flexible pipe were available to vary inlet and discharge distances. Adjacent pipes were easily joined with either bolts or quick clamps. Rubber gaskets were used to seal pipe connections. Large radius elbows were also available to change flow direction.



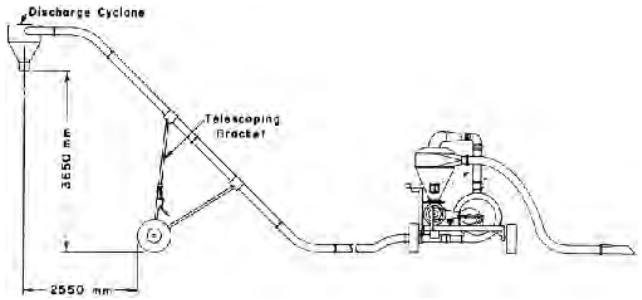


FIGURE 4. Mobile Discharge Cart.

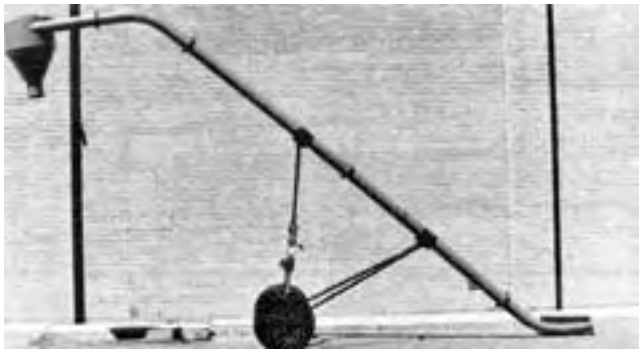


FIGURE 5. Cyclone Not Level when Telescoping Brackets Positioned as Specified.

Intake Nozzles: Two types of intake nozzles (FIGURE 6) were available. The round nozzle was used for normal grain conveying, while the flat nozzle was primarily used for bin clean-out. Both nozzles were easy to maneuver in a grain bin or truck box if only limited movement was needed. Either nozzle could be used to completely empty a grain bin. Due to the weight of the nozzle assembly and the bending resistance of the flexible piping, it was usually easier to sweep or shovel grain remaining on a bin floor to the nozzle than to attempt to completely clean a bin with a nozzle. A flexible pipe handle (FIGURE 7) was fabricated to facilitate handling the intake nozzle. It is recommended that a similar handle be supplied as standard equipment to aid in grain bin clean-out.

Transporting: The standard discharge assembly could be folded into transport position (FIGURE 8) by one man with wrenches, using the convenient winch provided, in less than 10 minutes. The transport height and weight of the Neuero 675 allowed it to be towed very well at speeds up to 30 km/h.

Hitching: The Neuero 675 was easily hitched to tractors with a 1000 rpm power take-off. The hitch jack was convenient. The hitch clevis was not adjustable to suit varying tractor drawbar heights.

Adjustments: The rotary air lock drive chain tension was easily adjusted with an idler sprocket. The slip clutch on the air lock was easy to adjust with the wrenches supplied.

Secondary air flow into the intake nozzle could be easily varied with an adjustable slide (FIGURE 6). As discussed below, the automatic air regulator, which indicated optimum air flow, did not always result in maximum conveying rates.

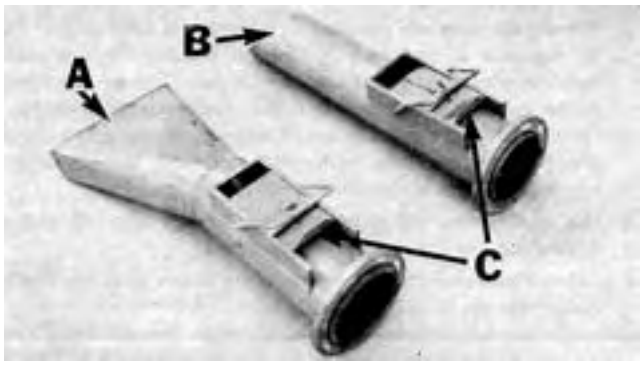


FIGURE 6. Intake Nozzles: (A) Flat Nozzle, (B) Round Nozzle, (C) Adjustable Slide.

FIGURE 7. Fabricated Flexible Pipe Handle.

FIGURE 8. Transport Position: (A) Winch.

Servicing: The Neuero 675 had one drive chain, 5 grease fittings and one gear box. The operator's manual recommended chain oiling and lubrication of the grease fittings every 15 hours and annual servicing of the gearbox and wheel bearings. About three minutes were needed to service the Neuero 675.

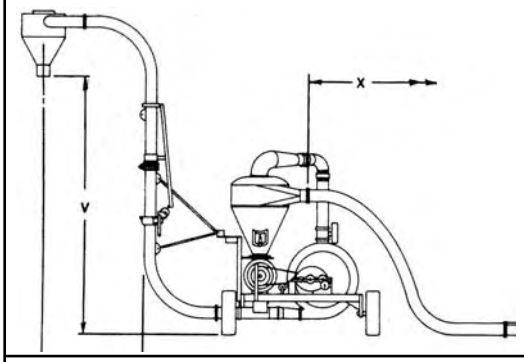
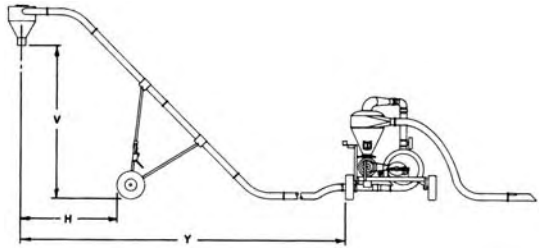
RATE OF WORK

Maximum Conveying Rates: Conveying rates for the Neuero 675 depended on the type of grain being conveyed, the intake nozzle slide setting, and the length of intake and discharge piping.

The conveying rate was very dependent upon maintaining a steady flow rate. A steady flow rate was difficult to achieve while cleaning a bin. Highest conveying rates were obtained with the intake nozzle, completely submerged in grain, with one length of flexible inlet pipe and the standard discharge assembly (FIGURE 2). As shown in TABLE 2, maximum conveying rates were 32.1 t/h in spring wheat, 36.9 t/h in barley, 34.7 t/h in oats, 27.4 t/h in rapeseed, 27.5 t/h in durum wheat, 34.3 t/h in rye and 14.7 t/h in granular fertilizer. The wide range of maximum conveying rates in TABLE 2 indicates the difficulty in adjusting the intake nozzle air slide to obtain maximum flow rate.

The amount of secondary air introduced at the intake nozzle slide was important in obtaining maximum delivery. Maximum conveying rates were not always obtained when the nozzle slide was set to obtain the recommended maximum reading on the air regulator. For example, in oats (FIGURE 9) the conveying rate was only 24.3 t/h when the nozzle slide was 70 mm open for maximum air regulator reading. The maximum conveying rate of 29.2 t/h occurred with a slide opening of 50 mm. Closing the nozzle slide about 15 mm less than the setting indicated by the air regulator usually resulted in increased conveying rates. Closing the nozzle slide more than this usually greatly reduced the conveying rate and increased the possibility of plugging. It is recommended that the manufacturer consider recalibration of the air regulator so that maximum regulator readings correspond more closely to maximum conveying rates.

TABLE 2. Conveying Rates at 1000 rpm Power Take-off Speed

	With Standard Assembly (Figure 2) and Various Intake Pipe Lengths Lift (V) = 3450 mm Reach (H) = 1600 mm			With Mobile Discharge Cart (Figure 4) One Length of Flexible Inlet Pipe and Various Discharge Pipe Lengths. Lift (V) = 3650 mm Reach (H) = 2550 mm	
					
	INTAKE PIPING LENGTH (X)			**DISCHARGE PIPING LENGTH (Y)**	
	4.6 m	**15.2 m**	**30.5 m**	**15.2 m**	**30.5 m**
Spring Wheat	29.1 to 32.1 t/h	19.6 to 23.8 t/h	14.7 to 17.1 t/h	18.0 to 22.0 t/h	16.9 to 19.9 t/h
Barley	31.4 to 36.9 t/h	20.3 to 25.5 t/h	18.7 to 21.6 t/h	18.6 to 23.0 t/h	15.9 to 21.2 t/h
Oats	30.1 to 34.7 t/h	25.0 to 27.1 t/h	20.0 to 25.3 t/h	25.4 to 28.5 t/h	23.1 to 24.5 t/h
Rapeseed	20.1 to 27.4 t/h	18.0 to 19.2 t/h	16.6 to 17.4 t/h	16.4 to 17.7 t/h	14.1 to 16.8 t/h
Durum Wheat	27.5 t/h				
Rye	34.3 t/h				
Granular Fertilizer	14.7 t/h				

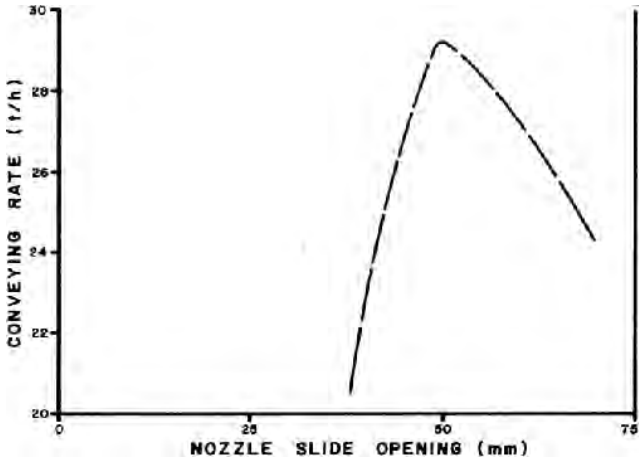


FIGURE 9. Conveying Rates in Oats for Various Nozzle Slide Settings (15.2 m Discharge Piping Length).

Effect of Pipe Length: Conveying rates decreased with increased intake pipe length. For example, increasing the intake length from 4.6 to 30.5 m (FIGURE 10) reduced the maximum conveying rate in spring wheat from 32.1 to 17.1 t/h. At the same intake length, the maximum conveying rate for barley decreased from 36.9 to 21.6 t/h and for oats it decreased from 34.7 to 25.3 t/h, while for rapeseed it decreased from 27.4 to 17.4 t/h.

FIGURE 10. Inlet Length of 30.5 m.

Increasing the discharge pipe length also reduced the conveying rate. The minimum length of discharge piping, when using the mobile discharge cart, was 15.2 m. Increasing the length to 30.5 m (FIGURE 11) reduced the conveying rate in spring wheat from 22.0 to 19.9 t/h, in barley from 23.0 to 21.2 t/h, in oats from 28.5 to 24.5 t/hand in rapeseed from 17.7 to 16.8 t/h.

FIGURE 11. Discharge Length of 30.5 m.

Comparison to a Grain Auger: TABLE 3 compares the performance of the Neuero 675 to that of an average 178 mm diameter, 12.5 m long, grain auger, at 30° inclination, with a lift of 6.4 m. Data for the Neuero 675 was obtained with the standard discharge and 4.6 m flexible intake piping. The maximum conveying rate for the Neuero 675 was 22% less than the grain auger in spring wheat, 23% greater than the grain auger in oats and 30% less than the grain auger in rapeseed.

TABLE 3. Comparison of the Neuero 675 to an Average 178 mm Diameter Grain Auger[1]

Grain Type	Maximum Conveying Rates (t/h)		Specific Capacities/Meter Vertical Lift (tkW-h)	
	Neuero 675	Grain Auger	Neuero 675	Grain Auger
Wheat	32.1	41.0	0.26	1.25
Oats	34.7	28.2	0.35	1.63
Rapeseed	27.4	39.4	0.29	1.03

[1]*The grain auger data represent average results from Prairie Agricultural Machinery Institute test reports E1977A, B and D.*

Specific capacity can be used to compare the conveying efficiency of t he two methods. A high specific capacity indicates efficient energy use while a low specific capacity indicates inefficient conveying. The specific capacity per metre of vertical lift for the grain auger was 5 times greater than that of the Neuero 675 in wheat, 4 times greater in oats and 3.5 times greater in rapeseed.

This indicates that pneumatic conveying is very costly and inefficient as compared to a grain auger.

POWER REQUIREMENTS

FIGURE 12 shows that the maximum power take-off input was 37 kW when the Neuero 675 was running empty and conveying only air. As grain was conveyed, less air was pumped, reducing power requirement. Power input during grain conveying depended upon the amount of air allowed to enter the conveyor as controlled by the intake nozzle slide. Power consumption decreased as the nozzle slide was closed. At maximum conveying rates, average power requirements were 35, 30, 26 and 25 kW in wheat, barley, oats and rapeseed respectively.

Start-up torques for the Neuero 675 were high. Engaging the power-take-off slowly reduced initial power requirements. However, a minimum tractor size of 45 kW was needed.

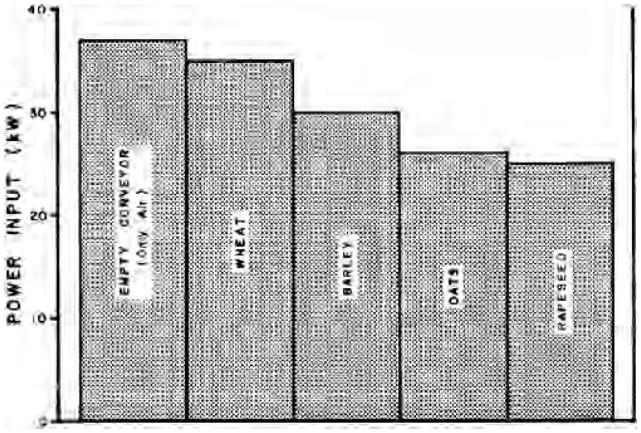


FIGURE 12. Average Power Requirements at Maximum Conveying Rates.

QUALITY OF WORK

Grain Damage: FIGURE 13 shows the increase in grain crackage each time a sample of dry wheat (10.5% moisture) was conveyed. In these tests the Neuero 675 was equipped with the standard discharge assembly (FIGURE 2) and a 4.6 m flexible intake pipe. The wheat initially contained 0.9% cracks. Each pass through the Neuero 675 caused an average 0.15% increase in crackage. This indicates that if the number of passes is kept to a minimum, grain damage should not be a problem. Test results[1] from grain augers in dry wheat have shown that each pass through an auger causes less

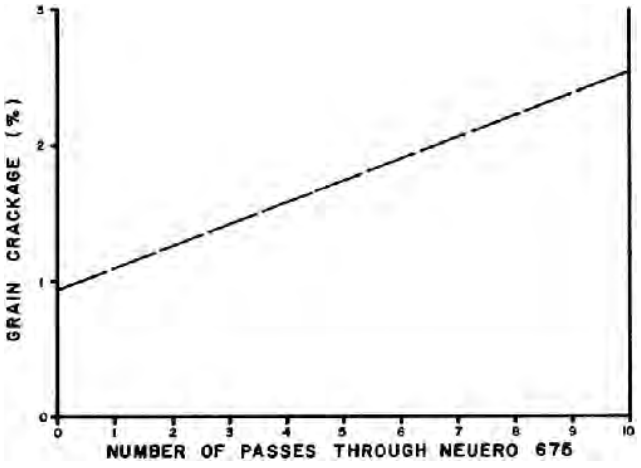


FIGURE 13. Grain Crackage in Dry Wheat.

Plugging: Plugging occurred when insufficient air entered the inlet to carry the material being conveyed. Proper adjustment of the inlet nozzle air slide was essential to prevent plugging. The Neuero 675 could be unplugged by discontinuing grain intake and allowing air to clear the blockage.

The separator cyclone screen partially plugged (FIGURE 14) when handling granular fertilizer, reducing the conveying rate. Thorough screen cleaning was needed after conveying fertilizer.

OPERATOR SAFETY

The Neuero 675 was safe to operate as all rotating parts were well shielded. The air intake nozzle was much safer to operate than a grain auger since there was no exposed flighting or rotating parts. Working near the intake nozzle was clean since most dust was conveyed into the inlet. Working near the discharge outlet was dusty.

FIGURE 14. Separator Cyclone Screen Plugged with Fertilizer.

Noise levels[2] near the Neuero 675, when powered with an 80 kW tractor, varied from 85 to 98 dBA, when operating on flat open fields. Noise levels when operating near metal bins, or in enclosed areas, were very loud and irritating. It is recommended that an operator wear suitable ear protection when working near the Neuero 675.

Both the Neuero 675 and the mobile discharge cart were low enough to safely pass under power lines.

OPERATOR'S MANUAL

The operator's manual was clearly written and contained much Useful information on operating, servicing, adjustments and safety precautions.

MECHANICAL PROBLEMS

TABLE 4 outlines the mechanical history of the Neuero 675 during 81 hours of operation. The intent of the test was functional evaluation. The following failures represent those, which occurred during functional testing. An extended durability evaluation was not conducted.

TABLE 4. Mechanical History

Item	Operating Hours
Trailer Assembly	
-The hitch clevis bent and was straightened at	4, end of test
Drive Mechanism	
-The hub of the rotary air lock had worn and was repaired at	58
Conveyor	
-The discharge tube below the rotary air lock cracked and was repaired at	71
-A section of flexible piping cracked at	37

DISCUSSION OF MECHANICAL PROBLEMS

Trailer Assembly: The hitch clevis bent twice (FIGURE 15) during transport on a smooth road. Modifications to increase clevis strength are recommended.

FIGURE 15. Bent Hitch Clevis.

Drive Mechanism: The hub on the rotary air lock wore (FIGURE 16) as a result of operation while the slip clutch was insufficiently tightened. Once the hub was worn, the slip clutch could not be properly tightened.

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[2]PAMI T791, Detailed Test Procedures for Determination of Noise Levels from Stationary Processing Equipment.

FIGURE 16. Worn Rotary Air Lock Hub.

Conveyor: The discharge tube below the rotary air lock cracked when the supporting brace slipped during transport (FIGURE 17).

FIGURE 17. Cracked Discharge Tube: (A) Crack, (B) Supporting Brace.

A 4.6 m length of flexible piping cracked (FIGURE 18) after being used as an inlet pipe for 37 hours. Cracking occurred adjacent to the separator cyclone inlet and was attributed to the repeated flexing experienced when wrapping the piping for transport.

FIGURE 18. Cracked Flexible Piping at Separator Cyclone Inlet.

APPENDIX I
SPECIFICATIONS

MAKE:	Neuero Pneumatic Grain Conveyor	
MODEL:	675	
SERIAL NUMBER:	336AL	
MANUFACTURER:	Neuero Corporation, Chicago, Illinois	
DIMENSIONS:	**Operating Position**	**Transport Position**
-- overall length	2320 mm	4800 mm
-- overall height	4450 mm	2800 mm
-- overall width	5140 mm	2590 mm
-- wheel tread	1970 mm	
INTAKE DISCHARGE PIPE:	152 mm diameter	
FLEXIBLE PIPE:	**Length**	**Weight**
	3050 mm	12.8 kg
	4575 mm	18.2 kg
RIGID PIPE:	3050 mm	6.3 kg
ROUND NOZZLE:	6.6 kg	
FLAT NOZZLE:	8.0 kg	
	Standard Discharge	**Mobile Discharge Cart**
DISCHARGE HEIGHT:	3450 mm	3650 mm
DISCHARGE REACH:	1600 mm	2550 mm

NUMBER OF LUBRICATION POINTS:
- -- 1 chain, 15 hour service
- -- 5 grease fittings, 15 hour service
- -- 2 wheel bearings, annual service
- -- 1 gearbox, annual service

DRIVES:	
-- power take-off	1000 rpm
-- fan drive	gear
-- rotary air lock	chain
DISCHARGE CYCLONE:	
-- weight	32 kg
TIRES:	2 tubeless radial, 1855R14

WEIGHT:	**Operating Position**	**Transport Position**
-- right wheel	531 kg	508 kg
-- left wheel	186 kg	309 kg
-- hitch	268 kg	168 kg
TOTAL	985 kg	985 kg

CENTRE OF GRAVITY:	**Operating Position**	**Transport Position**
-- above ground	974 mm	865 mm
-- forward of trailer axle	545 mm	340 mm
-- in from left wheel	1328 mm	1185 mm

MOBILE DISCHARGE CART WEIGHT:	
-- left wheel	88 kg
-- right wheel	l88 kg
-- at front pipe	-4 kg
TOTAL	172 kg

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

(a) excellent	(d) fair
(b) very good	(e) poor
(c) good	(f) unsatisfactory

APPENDIX III
METRIC CONVERSIONS

In keeping with the Canadian metric conversion program this report has been prepared in SI units. For comparative purposes, the following conversions may be used.

- 1 metre (m) = 1000 millimetres (mm) = 39.37 inches (in)
- 1 tonne (t) = 1000 kilograms (kg) = 2204.6 pounds (lb)
- 1 kilogram (kg) = 2.20 pounds (lb)
- 1 tonne per hour (t/h) = 2204.6 pounds per hour (lb/h)
  - 36.74 bushel per hour (bu/h) for 60 lb/bu wheat
  - 45.93 bushel per hour (bu/h) for 48 lb/bu barley
  - 64.84 bushel per hour (bu/h) for 34 lb/bu cats
  - 44.09 bushel per hour (bu/h) for 50 lb/bu rapeseed
- 1 kilowatt (kW) = 1.34 horsepower (hp)
- 1 tonne per kilowatt hour (t/kWh) = 27.42 bushel per horsepower hour (bu/hp-h) for
  - 60 lb/bu wheat
  - 34.28 bushel per horsepower hour(bu/hp-h) for 48 lb/bu barley
  - 48.38 bushel per horsepower hour(bu/hp-h) for 34 lb/bu oats
  - 32.90 bushel per horsepower hour(bu/hp-h) for 50 lb/bu rapeseed
- 1 kilometre per hour (kin/h) = 0.621 miles per hour (mph)
- 1 kilogram per cubic metre (kg/n^3) = 0.06 pounds mass per cubic foot (lb/ft^3)

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