SIMULATION AND ANALYSIS OF OLDSMOBILE DIVISION G. M. C. HOOD DAMAGE

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ABSTRACT

SIMULATION AND ANALYSIS OF OLDSMOBILE
DIVISION G.M.C. HOOD DAMAGE

By Leonard Joseph Meyer

Oldsmobile, Lansing Division of G.M.C., in the past year has been having problems in the correction of hood damage. These reports continually flow into their Packaging Methods Department from the other five divisional plants. To assist in curbing this branch plant discontent and hood damage costs, research was conducted and presented in this paper.

The research began with an analysis of all the damage reports received at Oldsmobile since September 1967. The analyses were made to determine: 1) where damage occurred, 2) what kind of damage occurred, 3) at which locations the damage reports were most prevalent. From the results of these analyses, indications were given of what to test for on the vibrational table. This helped in the determination of the most suitable vibrational motion to

use for the simulation of railcar damage. The three motions used to try and duplicate damage were: circular synchronous motion 30° out-of-phase, circular synchronous motion, and non-synchronous motion.

The motions were used to test two types of packing procedures. The first was conducted to test the present 1968 model hood packing methods. The second test was conducted to test the future packing methods in consideration by Oldsmobile.

The major findings of the report were: 1) Linden, New Jersey indicated itself as being the poorest destination for shipment of hoods; 2) Non-synchronous motion produced the best simulation of railcar motion and damage; 3) Banding repositioning and improved bar reworking were in order for change to help prevent damage; 4) In-yard railcar switching did not yield any conclusive results leading to hood damage.

SIMULATION AND ANALYSIS OF OLDSMOBILE

DIVISION G.M.C. HOOD DAMAGE

By

Leonard Joseph Meyer

A THESIS

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DEDICATION

In gratitude to my wife, Rosemarie, for her time and patience and assistance I wish to dedicate this paper.

ACKNOWLEDGEMENTS

This paper is written with appreciation extended to Dr. James Goff, Director of the School of Packaging, and to Mr. Arthur Chabot, Supervisor of Oldsmobile Packaging Methods Department, without whose permissions this presentation would not have been possible.

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LIST OF ABBREVIATIONS

Railroad Companies

(TP) Texas Pacific R.W.

(MP) Missouri Packfic R.W.

(GNW) Great North Western R.W.

(IC) Illinois Central R.W.

(CB&Q) Chicago Burlington & Quincy R.W.

(UP) Union Pacific R.W.

(G.T.W.) Grand Trunk Western R.W.

(N.Y.C.) New York Central R.W.

(SP) South Pacific R.W.

(PRR) Pennsylvania R.W.

(P) Pacific R.W.

(SOU) Southern R.W.

(PA) Pennsylvania Atlantic R.W.

(G.M.C.) General Motors Corp.

SIMULATION AND ANALYSIS OF OLDSMOBILE DIVISION G.M.C. HOOD DAMAGE

INTRODUCTION

Background

Elimination of branch plant discontent and high in-shipment hood damage costs are two objectives continually under Oldsmobile's scrutiny. (See Figure A1 in the Appendix for photographic representation of typical complaints.) To try to eliminate this dissatisfaction and high costs, the packaging methods department is being held responsible; as a result, a great deal of trial and error testing is being conducted. After a complaint is received the packaging department analyzes it and then tries to make the necessary corrective action. With each new correction, the department goes through a testing sequence to determine the feasibility of the design. The testing is essentially all trial and error, which includes the use of the vibration table and actual railcar shipment. If the design withstands the laboratory tests it is ready for use; and if the railcar shipments prove to be successful, the new method is continued in its use.

Purpose of the Report

It is the intent of this report to try and find what actually are the resultant factors contributing to the in-shipment hood damage; and then, it is the intent to find the probable solutions for them.

The points analyzed as possible contributors to shipment damage are: 1) analysis of time in transit versus hood damaged, 2) analysis of each railroad car used by Oldsmobile, 3) analysis of hood damage with respect to each sequential change in the rack design, and 4) analysis of damage versus destination. These analyses are broken down in the Appendix and shown in figure A2 and tables A1 and A2. Points 2 and 3 are combined in table A1 and table A2 is a composite of five separate analyses.

Considerations being used to try and locate or liquidate these and future problems are: 1) the use of the vibration table under three separate and distinct motions rather than one--as was used in the past (See figure A3 in the Appendix for graphic representation and explanation of these motions); 2) the use of a more efficient method of policing the packing and loading procedures, prior to shipment.

The Importance of the Report

The importance of this report is four-fold: 1) to try and give a possible grain of insight into the current causes of the damage, 2) to try and find better methods of policing packing and loading of hoods, 3) to try to reduce branch plant discontent, 4) to try and give some assistance to whomever may wish to pursue this course of action further.

DISCUSSION OF PROCEDURES

Results of the Analyses Presented in the Introduction

The analyses, which are broken down into Figure A2 and Tables A1 and A2 in the Appendix, were made with the final outcomes presented here. In Figure A2, it was concluded that time in transit versus hood damage presented no significant correlations. In Table A1, the concluding results indicated: 1) the packaging changes made no significant contribution to the elimination of damage reports; 2) the railcars, which had reported hood damage, did not reveal any defectiveness as; poor suspension, poor couplers, and draft gears, or flat wheels. Table A2c was also included in this analysis, where, railcars serving three or more destinations were checked for any correlation in the damage reports. The results indicated no correlations; therefore, it was determined that railcar defectiveness was not a major contributing factor to hood damage. In Table A2, the results of the five separate analyses indicated a direct correlation between destination and hood damage. Linden, New Jersey, showed the greatest affinity for the reported hood damage.

Concluding from these analyses, it was determined that: 1) Linden, New Jersey would serve as the best test run for any future trial shipments. Positive test runs to Linden would raise hopes for possible successful shipments to the other four destinations. The high damage reports received from Linden could be attributed to bad road beds, poor railroad tracks, closer inspection of incoming shipments, or poor engineering. Quoting a railroad engineer, " . . . setting all damage producing factors aside, damage to railcar contents is directly proportional to the ability of the engineer running the train . . . ." 2) Broken banding and releasing impact bars were the main constituents contributing to hood damage.

The testing, that follows, was conducted with two aspects in mind: 1) Testing was conducted to provide a more effective means of banding and of locking in impact bars for the 1968 model-car-hood shipments; 2) Testing was conducted with the future shipments in mind--1969 model car hoods. The testing in this part was directed toward the elimination of banding in favor of a plastic coated metal spacer, which to date had already shown signs of star quality in test runs, and to continue the testing of the impact bar.

Testing of 1968 Model Hood
Packing Methods

The use of the vibrational table in the following four test tables was designed specifically to try and duplicate the various damage reports received at Oldsmobile in the last nine months.

Table 1, below, was conducted with the table set in circular synchronous motion 30° out-of-phase. With this motion it was hoped that the pitching or rotational vibrations produced in the railcars could be partially simulated. In actual railcar shipments these vibrations are amplified significantly whenever the exciting frequency matches the natural pitch frequency of the railcar, and its contents; as a result, this may be damage producing.

Testing, as indicated in the table, gave negative results from 140-210 cpm; however, it was interesting to note that at 180 cpm the rack began to cycle out of phase every three to four seconds. As a result, the new rack motion caused it to impact hard against the table bed. The impacting caused the hoods to shake violently. The

TABLE 1.--Circular Synchronous Motion 30° out-of-phase Testing of Current Packing

Running Times (Min.)	Cycle Settings (Cpm)	(Cps)	Results
15,30.60,120, 180,210	140	2.3	Negative
"	150	2.5	"
"	160	2.7	"
"	170	2.8	"
"	180	3.0	"
"	190	3.2	"
"	200	3.3	"
"	210	3.5	"
"	220	3.7	Impact bar released once in 30 min. test and twice in each of the remaining test periods
15,30	230	3.8	Negative, at this point, due to the severity of vibration and safety reasons, testing was limited to the short testing periods
"	240	4.0	
"	250	4.2	
"	260	4.3	
"	270	4.5	
"	280	4.7	

shaking and impacting resulted in the loosening of the impact bar pin; however, the pin never completely worked itself free until 220 cpm.

When the testing reached 220cpm and the impact bar released it was felt that the test was successful in duplicating one cause which attributed to hood damage; however, inspection of the bar indicated it had a defective locking mechanism originally. This result would have left the test a failure if the new impact bar would have stayed locked into place; however, the new bar released eight more times at 220 cpm making the test successful in the duplication of one cause of damage. No redesigning of the impact bar lock was considered at this time. The other motions were planned to be used first; then, the motion yielding the most responsive duplicating of both the band breaking and impact bar releasing would be used to test any redesign ideas.

As the testing proceeded beyond 220 cpm little evidence was given for any type of damage duplication. With workmen working and resting in the vicinity of the vibration table the testing had to be abbreviated for safety reasons. The testing, therefore, was limited to only the fifteen and thirty minute test durations. It was felt, however, as a result of the first two time periods of each test, that the extended test periods would not have yielded any significant results.

Table 2, page 9, was conducted with the table set in circular synchronous motion. Using this motion the vibration table did not simulate any damage producing factors, which had occurred in railcar shipments. As a result, this motion was considered as non-effective and

TABLE 2.--Circular Synchronous Motion Testing of Current Packing

Running Times (Min.)	Cycle Settings (Cpm)	(Cps)	Results
15,30,60,120,180	140	2.3	Negative
"	150	2.5	"
"	160	2.7	"
"	170	2.8	"
"	180	3.0	"
"	190	3.2	"
"	200	3.3	"
"	210	3.5	"
"	220	3.7	"
"	230	3.8	"
"	240	4.0	"
"	250	4.2	"
"	260	4.3	"
"	270	4.5	"
"	280	4.7	"

should not be used as a means for testing the simulation of hood damage.

Tables 3a and 3b, page 10, were conducted with the table set in non-synchronous motion. Using this motion, excellent results were produced, which were indicative of those produced in railcar shipments.

It was discovered at the commencement of the testing that, due to the severity of the rack vibration, restraints had to be made. The lateral movement of the rack was thwarted by chaining it to the side of the table. The

TABLE 3.--Non-synchronous Motion Testing of Current Packing

a.

Running Times (Min.)	Cycle Settings (Cpm)	(Cps)	Results
5	140	2.3	Negative
10	"	"	"
15	"	"	Impact Bar Released
20	"	"	" " "
28	"	"	Metal Band Snapped

b.

Running Times (Min.)	Cycle Settings (Cpm)	(Cps)	Results
5	140	2.3	Negative
10	"	"	"
15	"	"	Impact Bar Released
20	"	"	" " "
29	"	"	Metal Band Snapped

forward movement was restricted by nailing two by four's into the table bed in front of the rack. The two by four's were so placed to allow the rack a maximum movement of four inches either backward or forward. Using these restraints caused the rack to vibrate violently; however, the rack seemed to be lacking good longitudinal motions. As a result, three one inch shims were used to reduce the table movement longitudinally to a maximum of one-inch. These conditions seemed ideal for testing; however, they were too violent to be carried on beyond 140 cpm. Therefore,

all the non-synchronous motion testing was carried on under these conditions.

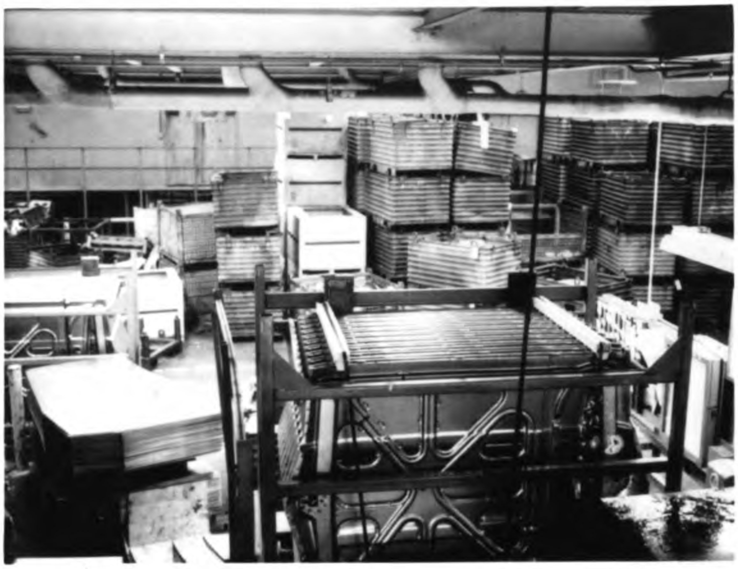
The tests during the first two periods were negative; however, the pins locking in the impact bar did loosen. From the fifteen minute period on, the bar released between twelve to fourteen minutes into each test. Finally, at twenty-eight minutes the high tensile three-quarter inch by .031 inch band snapped. To test the validity of the results in Table 3a the test was rerun with almost identical results.

Following these tests the bands were repositioned to check if breakage, due to band tension, could be reduced.

Table 4a and 4b gave almost identical results with both indicating that band repositioning offered possibilities for consideration; however, even though the results afforded some recognition over 3a and 3b it was not enough to warrant complete change-over. Minor alterations to the hood spacers would have to be made, first, before changes could have been made. To extend the test with hope of validating the change-over a new three-quarter by .035 inch banding was ordered. It was felt that this more flexible

Fig. 1.--Original Banding Locations

a. Top View



b. Side View

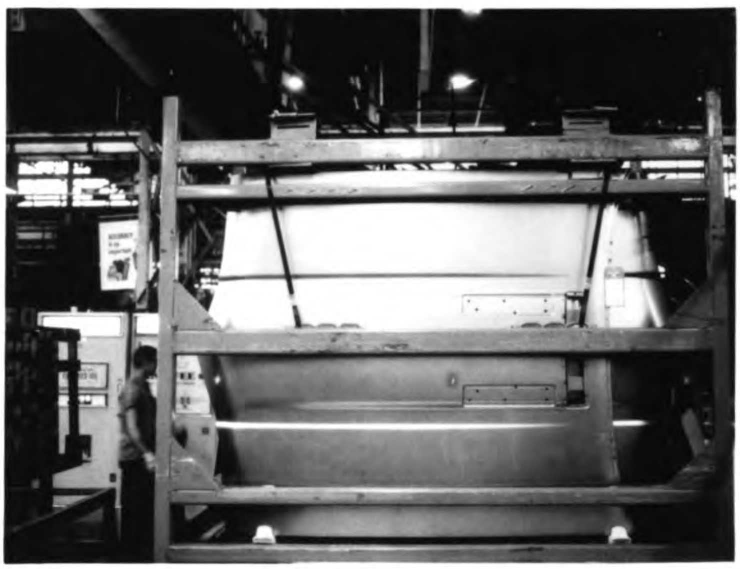


Fig. 2.--Banding Relocations

a. Top
View

b. Side
View

TABLE 4.--Non-synchronous Motion Testing of Revised Packing Ideas

a.

Running Times (Min.)	Cycle Settings (Cpm)	(Cps)	Results
5	140	2.3	Negative
10	"	"	
15	"	"	Impact Bar Released
20	"	"	
30	"	"	
42	"	"	Metal Band Snapped

b.

Running Times (Min.)	Cycle Settings (Cpm)	(Cps)	Results
5	140	2.3	Negative
10	"	"	
15	"	"	Impact Bar Released
20	"	"	
30	"	"	
45	"	"	
50	"	"	Metal Band Snapped

band would offer longer periods of staying intact; therefore, it would warrant the banding repositioning, and divider alterations. Due to the slow arrival of the new banding material the testing of banded hood racks ended here.

Summarizing the results these tests, it can be positively stated that non-synchronous motion was the best motion for the simulation of what causes hood damage, namely broken bands and released impact bars. It was realized that

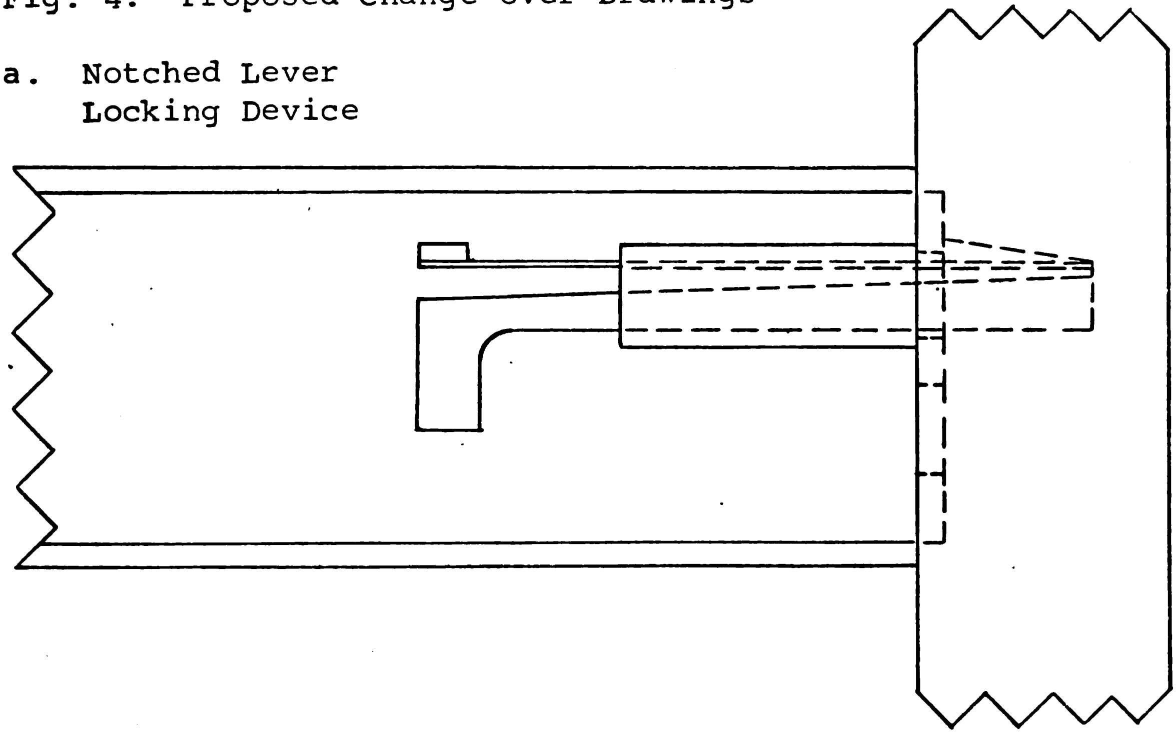
the vibrations produced under this motion were or may have been more severe than those in a railcar, due to the increased severity of the tests under the restraining conditions. These conditions could lead to over-packaging even though this would be an excellent beginning point since this is the first time damage factors had been reproduced with regularity and in approximately sixteen times faster than previous methods.

During the testing no changes were made on the impact bar locking device due to limited time; however, Figure 3, page 15, has a photograph of the current locking device and Figure 4, page 16, has the two proposed change-over drawings, scaled to 1/2" = 1". Figure 4a proposal has used the same housing for the locking pin; however, modifications

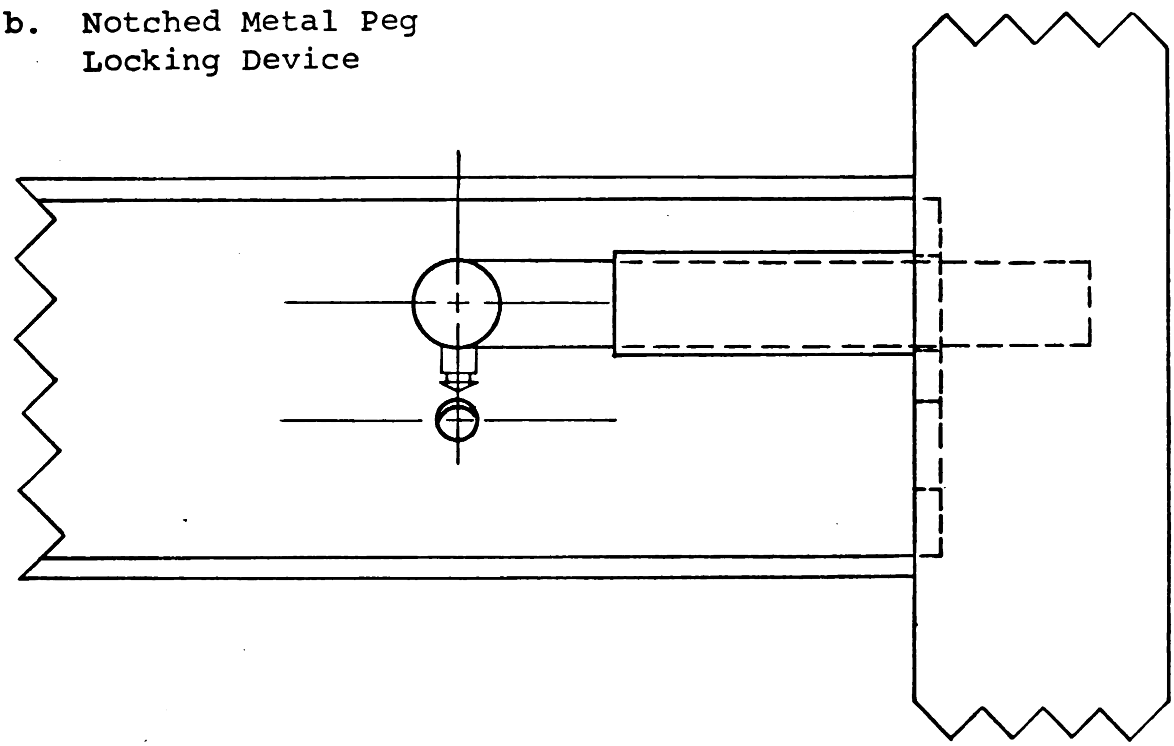
Fig. 3.--Impact Bar Locking Device

Fig. 4.--Proposed Change-over Drawings

a. Notched Lever
Locking Device



b. Notched Metal Peg
Locking Device



were made on the pin. The pin was cut in a declining angle from front to the rear to allow clearance for the depression of the notched lever, which was attached to the front of the pin. In actual use the pin could easily be slid into place and withdrawn by depressing the lever to allow room for the notched area to pass through the hole.

Figure 4b proposal, again, uses the same housing unit for the pin, with modifications again made on the pin. The change consisted of welding, at a downward angle, a notched metal peg on to the back end of the pin. The purpose of the notch would be to serve as a location where a clip could be attached, after the peg was pushed through the angled hole in the impact bar. The clip would be easy to insert, to restrict the movement of the pin, and it would also be easy to pull off to release the pin and lock.

Testing of Possible Revisions for 1969 Hood Packing

The testing in the following three tables was conducted to test possible revisions in the retention methods for 1969 hoods. These revisions were considered since banding had been the major contributor to hood damage in the past.

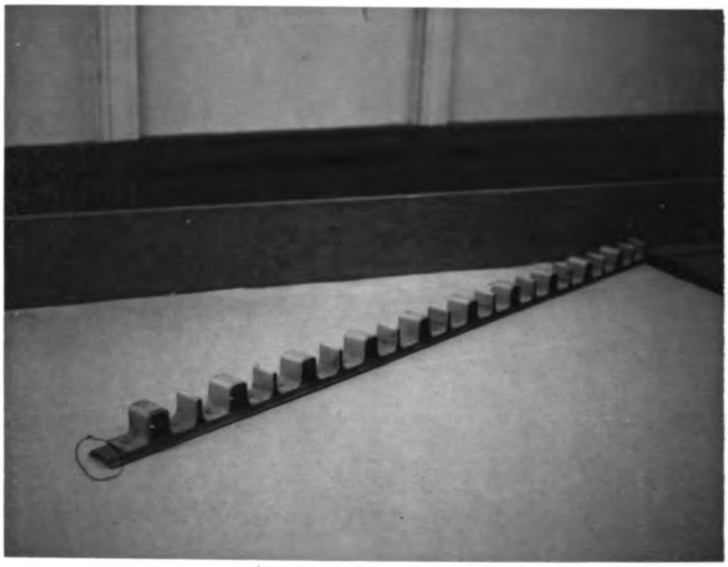
Testing in Table 5 was conducted with the table in synchronous motion 30° out-of-phase. The new hood retention revision used consisted of an aluminum bar with a plastic coated steel insert (See Figure 5 for new insert).

TABLE 5.--Circular Synchronous Motion 30° out-of-phase Testing of Future Packing Ideas

Running Times (Min.)	Cycle Settings (Cpm)	(Cps)	Results
10	140	2.3	Negative
"	150	2.5	"
"	160	2.7	"
"	170	2.8	"
"	180	3.0	"
"	190	3.2	"
"	200	3.3	"
"	210	3.5	Impact bar released twice
"	220	3.7	Two impact bars released, nuts and lock washers were stripped of bolts connecting the hood divider with the rack

As presented above, the testing was limited to a short running time and a short range of cycle settings. This was attributed to large holes produced in the aluminum bars through wear from loose bolts, and also as a result of the wear into the end of the metal divider during the test period--wear is illustrated in figure 5, page 19. The wear on the parts can be attributed to the force of the hoods moving the insert backward and forward. This sliding

Fig. 5.--Plastic Coated Metal Hood Spacer



motion was always abruptly stopped by the insert slamming into the vertical bar holding the insert and bar in position. As the slamming continued the hoods shook with an increasing momentum; as a result, caused increased damage to the insert.

Table 6 below was a continuation of table 5 with the exception of a revision made on the aluminum bar. The revision consisted of welding an aluminum slug across the slot at the end of the bar. This had the affect of limiting the sliding motion of the insert and the movement of the hoods. (See Figure 6 for revisions, page 21.)

TABLE 6.--Revision 1

Running Times (Min.)	Cycle Settings (Cpm)	(Cps)	Results
10	140	2.3	Negative
"	150	2.5	"
"	160	2.7	"
"	170	2.8	"
"	180	3.0	"
"	190	3.2	Impact bar released
"	200	3.3	" " "
"	210	3.5	Al piece knock out off both ends of left-hand separator and one end of right-hand separator

The new revision limited the hood motion to a short backward and forward motion; as a result, the hoods shook less violently. The test proceeded along with indications of appearing to offer positive results, when at 230 cpm three of the four slugs were broken from their welds. The testing was stopped and the hoods were checked for any damage. Along the top of the hoods, where the insert held the hoods apart, there were small repairable dents. A visual inspection of the insert revealed the apparent cause of the damage. The plastic, which coated the metal, started to flow and formed a little ball on the end of each

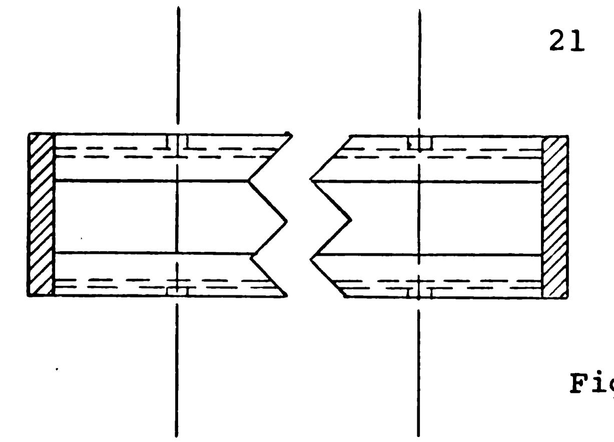
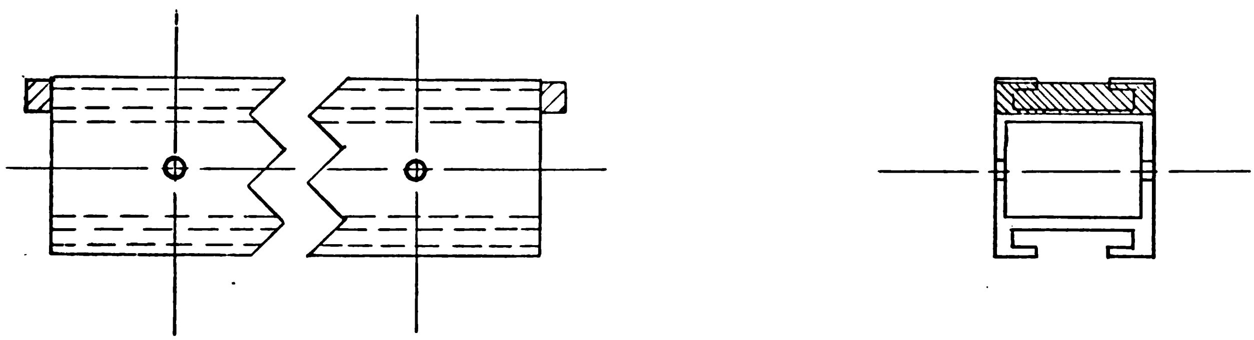
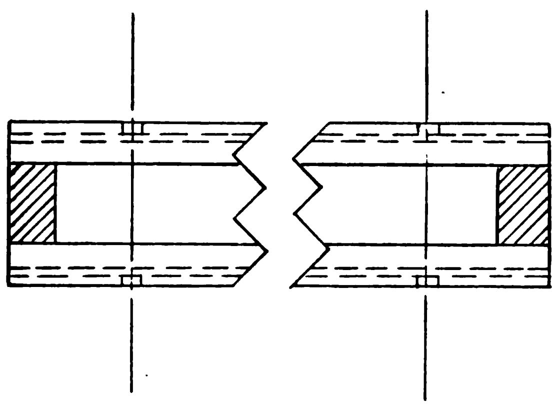


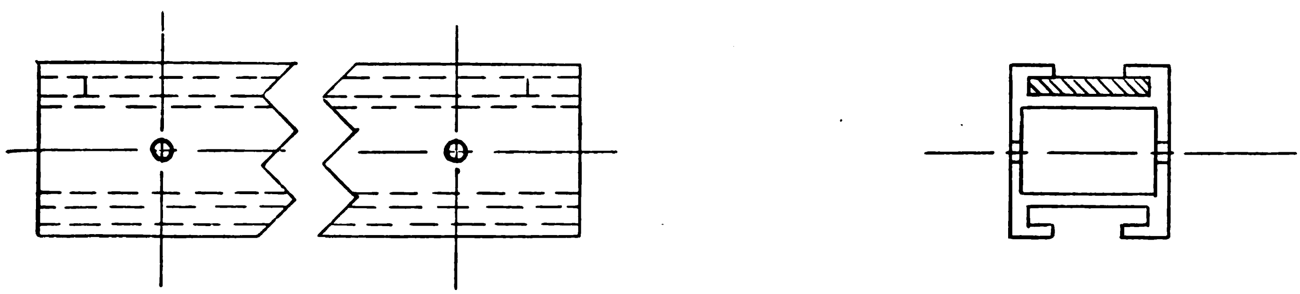
Fig. 6.--Aluminum Bar Revisions

a. Plug Welded Externally





b. Plug Welded Internally



spacing unit, like that of the ball formed by forcing air to the end of a balloon. The ball serves as a hammer with each contact with the hood and resulted in the dents.

Table 7, the second revision, is a continuation of tables 5 and 6. The second revision consisted of fitting and welding an aluminum slug into the slot at the end of the aluminum bar to restrict the insert movement completely.

TABLE 7.--Revision 2

Running Times (Min.)	Cycle Settings (Cpm)	(Cps)	Results
10	140	2.3	Negative
"	150	2.5	"
"	160	2.7	"
"	170	2.8	"
"	180	3.0	"
"	190	3.2	"
"	200	3.3	"
"	210	3.5	Impact Bar Released
"	220	3.7	Al piece knock loose from bar

From the outset, the new revision accomplished what it was intended to do, namely, to restrict the movement of the hoods in the rack. This was accomplished throughout the test with the hoods and rack moving as one unit with each motion of the table.

After an elapsed time of three minutes into the 220 cpm test the weld on the left retention bar broke loose. The test was terminated, at this point, and the hoods were checked for visible damage; however, there were no indications of any damage. Testing was terminated here as a result of the limited availability of the testing facilities.

Summarizing, the three tests indicated a possibility for future considerations. If a new or stronger weld could be structured the testing could be continued through the other two motions. This testing should be advanced prior to on-line shipping, which could result in costly trial and error shipments.

Policing of Packing and Loading Procedures

Consideration was given to these procedures as a result of casual inspections of the loading and packing of hoods. At times mishandling of racks by the forklift truckers resulted in dented hoods, and at times packing neglect resulted in the impact bars being left unlocked.

Close surveillance of rack handling will not always rectify conditions as these. Handlers have to be

constantly made aware of the consequences of laxness. To date this has not been a serious problem; however, it cannot be left unconsidered if damage reduction is to be completely achieved.

The major problem area lies in the packing of the hoods. It was discovered upon frequent trips to the packing area that impact bars were not always locked. On occasion, when pins offered sliding resistance, the lock was left open rather than being forced shut or having the impact bar replaced with efficient locking devices.

A sample was taken of ten different carload shipments, where eight racks per car were visible, for unlocked impact bars. Of the eighty visible racks twelve racks had at least one unlocked impact bar. An average of 1.5 unlocked impact bars per railcar seemed low; however, with consideration given to the unseen racks this average could have been higher. The unlocked bars may have never fallen out of place, but nevertheless, a potential damaging condition did exist and had to be given consideration. Closer inspection by those concerned would have increased the probability for fewer damage reports.

SUMMARY AND CONCLUSIONS

In summarizing it was hoped that this paper presented a feeling for the existing hood damaging problems at Oldsmobile, and that the approach to the solution of the problems could lend assistance to whomever wished to further pursue this course of action.

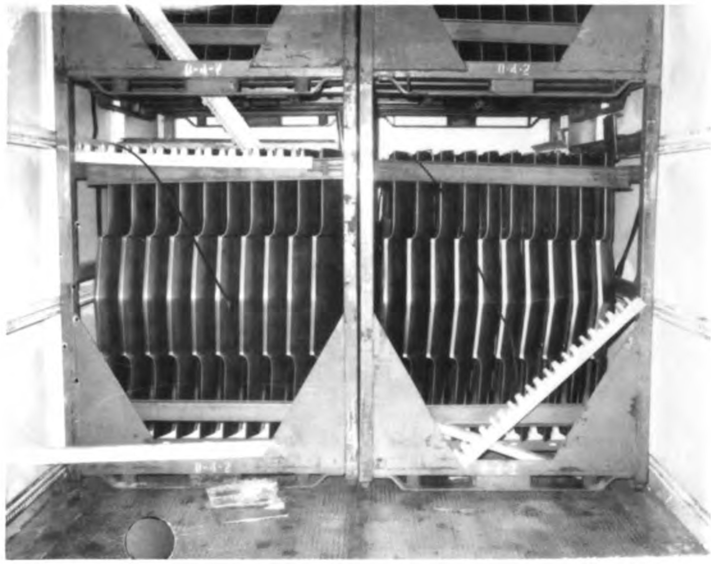
In testing of the 1968 banding procedures, the vibration table was able to simulate damage consistently using non-synchronous motion. The revisions made on the rack indicated that the hoods would be able to endure greater shocks than the original procedures; however, new banding material should extend the period of protection. If banding is eliminated in future models, the testing of the possible revisions indicated that the plastic-coated metal dividers would be a superior change-over from the banding procedures.

In concluding, the trial and error testing that was used was, to an extent, successful; however, the purpose of this paper was to try to eliminate the trial and error testing in favor of quantitative testing. This

approach would have been presented if the on-line testing had been permissible. Then the correlation of the on-line result with the damage report analysis should have provided sufficient data to proceed in a technical manner.

APPENDIX

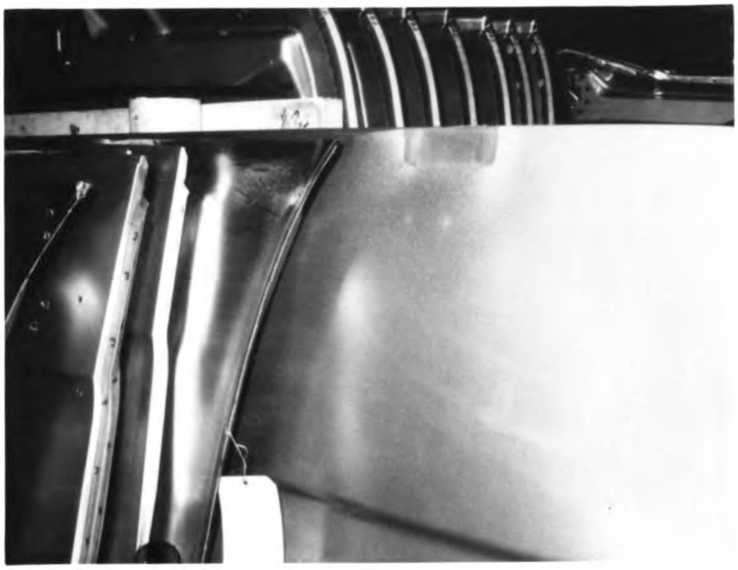
Fig. A1.--Typical Complaints



a. Broken
Bands

b. Released
Impact Bar

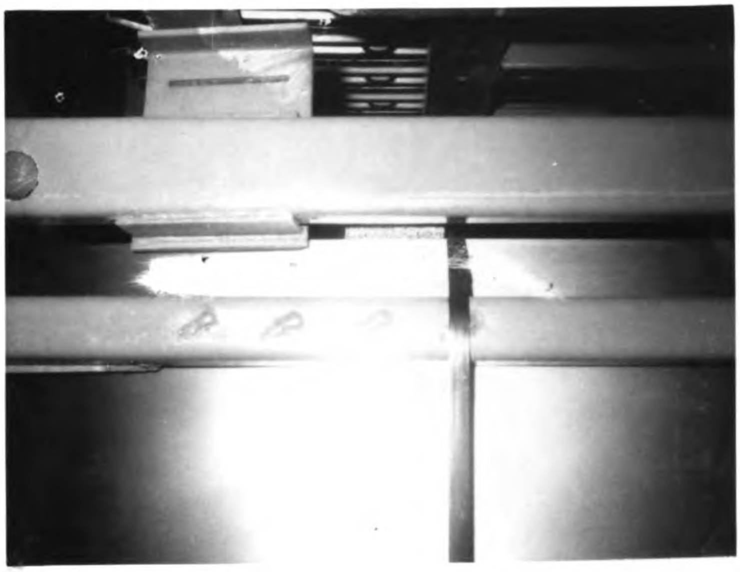
Fig. A1.--Cont.



c. High Banding
Tensions

d. Poor Materials
Handling

Fig. A1.--Cont.



e. Rest Pad
Too High

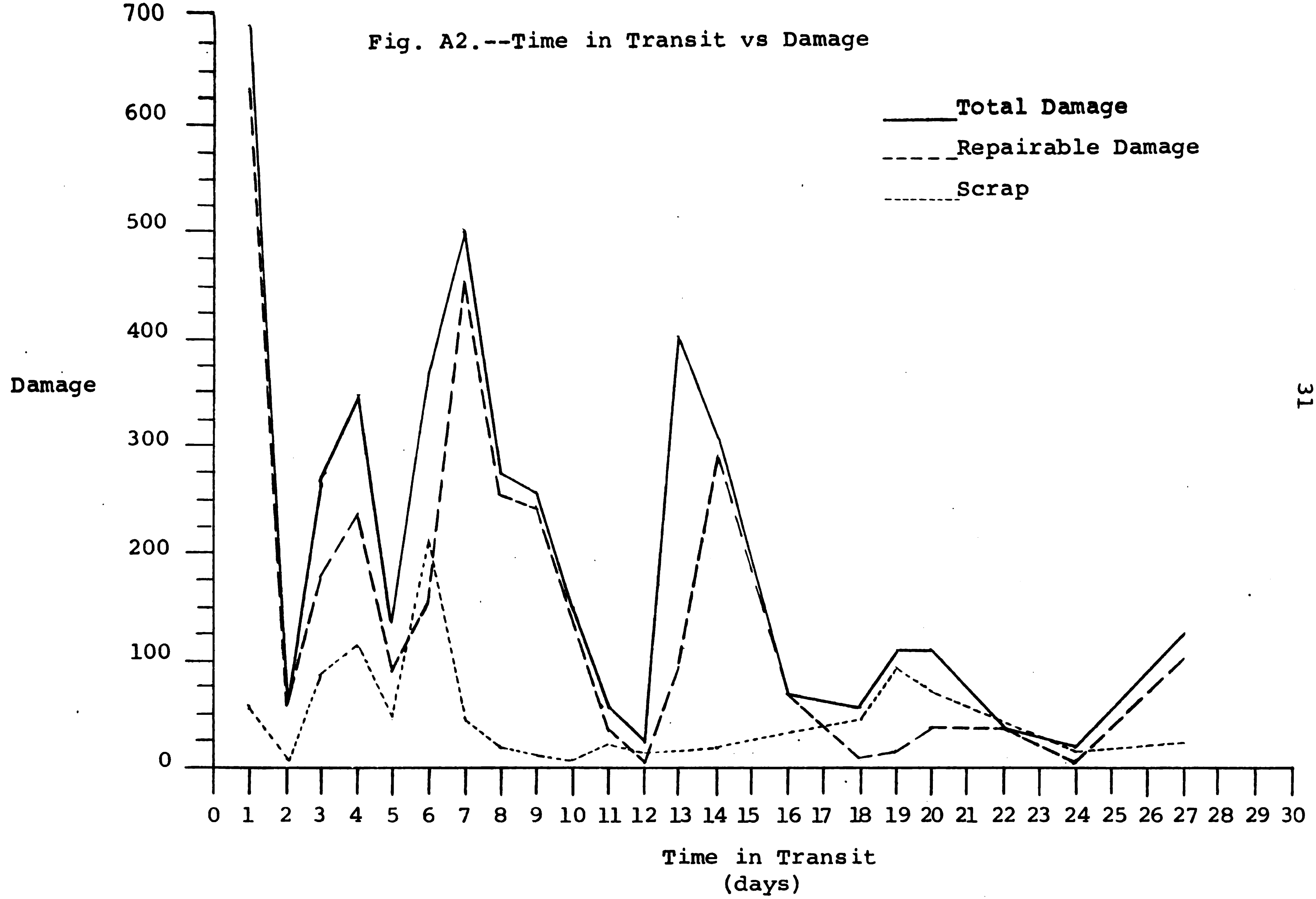


Fig. A2.--Time in Transit vs Damage

TABLE A1.--Analysis of Damage in Railcar After Each Packaging Change

Month	Destination	Railway and Car	Total Shipped	Total Damaged	Packaging Changes
Aug.	Fremont	PRR125554	280	26	
	Kansas City	GTW378229	238	4	
	South Gate	TP272045	238	57	
Sept.	Fremont	TP272049	280	91	New banding tools used to control banding tension
		UP980258	260	27	
		UP980258	260	44	
		SP615270	280	73	
		MP270507	80	23	
	Kansas City	UP980254	238	3	
		UP980256	238	3	
		UP980250	238	13	
	South Gate	UP980257	238	8	
		NYC67636	238	3	
Oct.	Fremont	IC44282	280	48	One piece plastic spacers put into use for testing purposes to be use intermittently
		TP980251	280	40	

Table A1.--Cont.

Month	Destination	Railway and Car	Total Shipped	Total Damaged	Packaging Changes
	Linden	GTW378219	280	70	
		SP615271	280	137	
		NYC67637	82	16	
	Kansas City	UP980254	238	6	
		NYC67640	238	25	
		UP980259	238	18	
	South Gate	CB&O15107	238	13	
		GTW378221	238	5	
Nov.	Fremont	980251	280	130	Banding tensions changed
	Kansas City	GTW378226	238	3	Bands wired into place
		GTW378220	238	2	
		TP272049	238	42	
	South Gate	MP980255	238	139	
		GTW378228	238	8	
		GNW92091	238	9	
		GTW398222	238	20	
	Atlanta	SOU16180	238	36	

Table A1.--Cont.

Month	Destination	Railway and Car	Total Shipped	Total Damaged	Packaging Changes
Dec.	Fremont	TP272049	280	106	
		980252	140	14	
		NYC67635	160	30	
		TP272048	260	69	
	Linden	NYC67640	238	68	
		GTW378223	255	11	
	Kansas City	UP980259	238	69	
		SP615270	238	9	
		TP272047	238	9	
	South Gate	UP980257	238	83	
		NYC67641	238	120	
	Atlanta	TP272046	238	36	
		PA125563	238	18	
Jan.	Fremont	UP980259	280	94	Bands stapled to plywood corner protectors
		NYC67367	300	43	
		SP615271	280	75	
		NYC67640	240	43	
	Linden	NYC67636	255	17	

Table A1.--Cont.

Month	Destination	Railway and Car	Total Shipped	Total Damaged	Packaging Changes
	Kansas City	GTW378223	238	17	
		NYC67639	238	3	
		IC44282	238	36	
		UP980254	238	8	
		PRR125554	238	17	
		TP272050	340	7	
		UP980257	238	85	
		UP980258	136	34	
	South Gate	UP980255	238	20	
		UP980250	238	80	
		GTW378232	238	17	
	Atlanta	TP272049	255	54	
		SOU17444	255	36	
Feb.	Fremont	UP980257	280	37	Revisions made to hold locks into place on impact bars
		GTW378238	280	36	
		GTW347233	140	16	
	Kansas City	UP980255	238	82	
		SP615271	238	28	
		GTW378220	238	6	
	South Gate	IC44282	238	143	
		CB&O15107	238	20	
		UP980256	238	92	

Table A1.--Cont.

Month	Destination	Railway and Car	Total Shipped	Total Damaged	Packaging Changes
Mar.	Fremont	GTW378238	260	42	New spacer blocks used
	Linden	UP980251	275	133	
		IC44282	275	132	
		GTW378236	230	137	
		UP980257	280	127	
		CB&O15106	280	125	
		P125559	154	71	
		NYC67639	280	115	
		UP980252	280	95	
		TP272045	269	85	
		PRR125553	280	106	
		UP980253	260	139	
		PRR125556	260	92	
		GTW378218	280	105	
	Kansas City	GTW378230	238	4	
		UP980258	238	17	
	South Gate	GTW378221	238	41	
Apr.	Linden	GTW378234	280	177	
	Kansas City	UP980257	238	15	
		GTW378233	204	17	
		PRR125557	238	3	

TABLE A2.--Analyses of Destination vs. Hood Damage

a) Analysis of Destination and Damage versus Total Number of Hoods Shipped

	Fremont	Linden	Kansas City	South Gate	Atlanta
Total Hoods Shipped	17,640	14,909	53,108	12,709	19,567
Total Reported Damage	1,112	1,782	630	814	162
Percent of Damage	6.3	11.9	1.2	6.4	0.8

b) Analysis of Destination versus the Amount of Damage in Damaged Shipments

	Fremont	Linden	Kansas City	South Gate	Atlanta
Total Hoods in Damaged Shipments	5,120	3,273	6,702	4,284	1,258
Damage in Damaged Shipments	1,112	1,719	630	958	162
Percent of Damage	21.7	52.5	9.4	22.4	12.9

Table A2.--Cont.

c) Analysis of In-Route Damage Versus Railroad Cars Used for Three or More Destinations

	Fremont	Linden	Kansas City	South Gate	Atlanta	Railway Used
Total Hoods Shipped	840	265	238	238	255	(TP) Texas Pacific
Reported Damage	237	85	42	57	54	
Percent of Damage	28.2	32.1*	17.7	24.0	21.2	
Total Hoods Shipped	280	280	476	---	---	(PRR) Penn-sylvania
Reported Damage	26	106	51	---	---	
Percent of Damage	9.3	37.8*	10.7	---	---	

*Destination with the highest percent of damage.

Table A2.--Cont.

	Fremont	Linden	Kansas City	South Gate	Atlanta	Railway Used
Total Hoods Shipped	1,080	280	2,754	1,190	---	(UP) Union Pacific
Reported Damage	202	127	343	283	---	
Percent of Damage	18.7	45.4*	12.5	24.6	---	
Total Hoods Shipped	560	280	476	---	---	(SP) Southern Pacific
Reported Damage	148	137	65	---	---	
Percent of Damage	26.4	48.9*	13.7	---	---	

*Destination with the highest percent of damage.

Table A2.--Cont.

	Fremont	Linden	Kansas City	South Gate	Atlanta	Railway Used
Total Hoods Shipped	280	275	238	238	---	(IC) Illinois Central
Reported Damage	48	132	36	143	---	
Percent of Damage	17.1	48.0	15.1	60.1*	---	
Total Hoods Shipped	540	1,155	714	238	---	(NYC) New York Central
Reported Damage	86	216	37	3	---	
Percent of Damage	15.9	20.5*	5.2	1.3	---	

*Destination with the highest percent of damage.

Table A2.--Cont.

	Fremont	Linden	Kansas City	South Gate	Atlanta	Railway Used
Total Hoods Shipped	540	255	714	476	---	(GTW) Grand Trunk Western
Reported Damage	78	11	25	46	---	
Percent of Damage	14.4*	4.3	3.5	9.7	---	

d) Analysis of Which Hoods Received Greatest Amount of Damage

Hood Number	Total Made*	Total Damage	Percent of Damage in Total Shipped
398496	15,648	1,356	8.7
398409	16,901	1,475	8.7
398272	48,956	612	1.3
402416	36,428	1,138	3.1

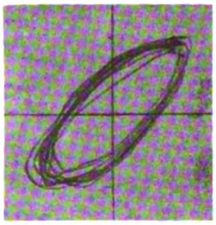
*Destination with the highest percent of damage.
*Total number made and shipped as of 9 April 1968.

Table A2.--Cont.

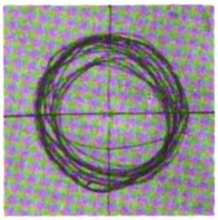
e) Analysis of Hood Damage--by Hood Number--versus Destination

Destination	Hood Number	Total Shipped	Total Damage	Percent of Damage in Total Shipped
Fremont	398409	9,240	628	6.8
	398496	8,400	484	5.8
Linden	398409	7,661	847	11.6
	398496	7,248	872	12.0
Kansas City	398272	30,263	234	0.8
	402416	22,845	396	1.7
South Gate	398272	6,657	342	5.1
	402416	6,052	616	10.2
Atlanta	398272	12,036	36	0.3
	402416	7,531	126	1.7

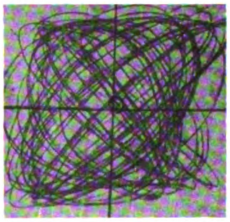
Fig. A3.--Motions Used in Vibrational Testing*



Circular synchronous motion 30 out-of-phase. Motion above was produced with the eccentrics on the secondary shaft 30 out-of-phase from those on the primary shaft. Again, both shafts operate at the same speed but because of the out-of-phase relationship of the shaft eccentrics, the table surface tilts as it describes an elliptical path. This type of motion reduces the top swing on high loads and also introduces some of the side sway encountered in normal transportation.



Circular-synchronous motion. Motion above was produced by setting the eccentrics on the two shafts in phase with each other with both shafts operating at the same speed. Consequently, the table surface remains level as it travels in a 1" diameter circle.



Non-synchronous motion. This motion is the most difficult one to visualize, since it is random or erratic. When this motion is produced, the primary and secondary shafts operate at slightly different speeds causing the phase relationships of the eccentrics on the two shafts to change continuously. This results in an intermittent tipping action when the eccentrics progress to a point where they are briefly 180 out of phase. They continue to change phase relation until they are briefly in phase again and so on.

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*L.A.B. Corporation, Skaneatbles, N.Y. Package Tester Motions, 4-8-63.