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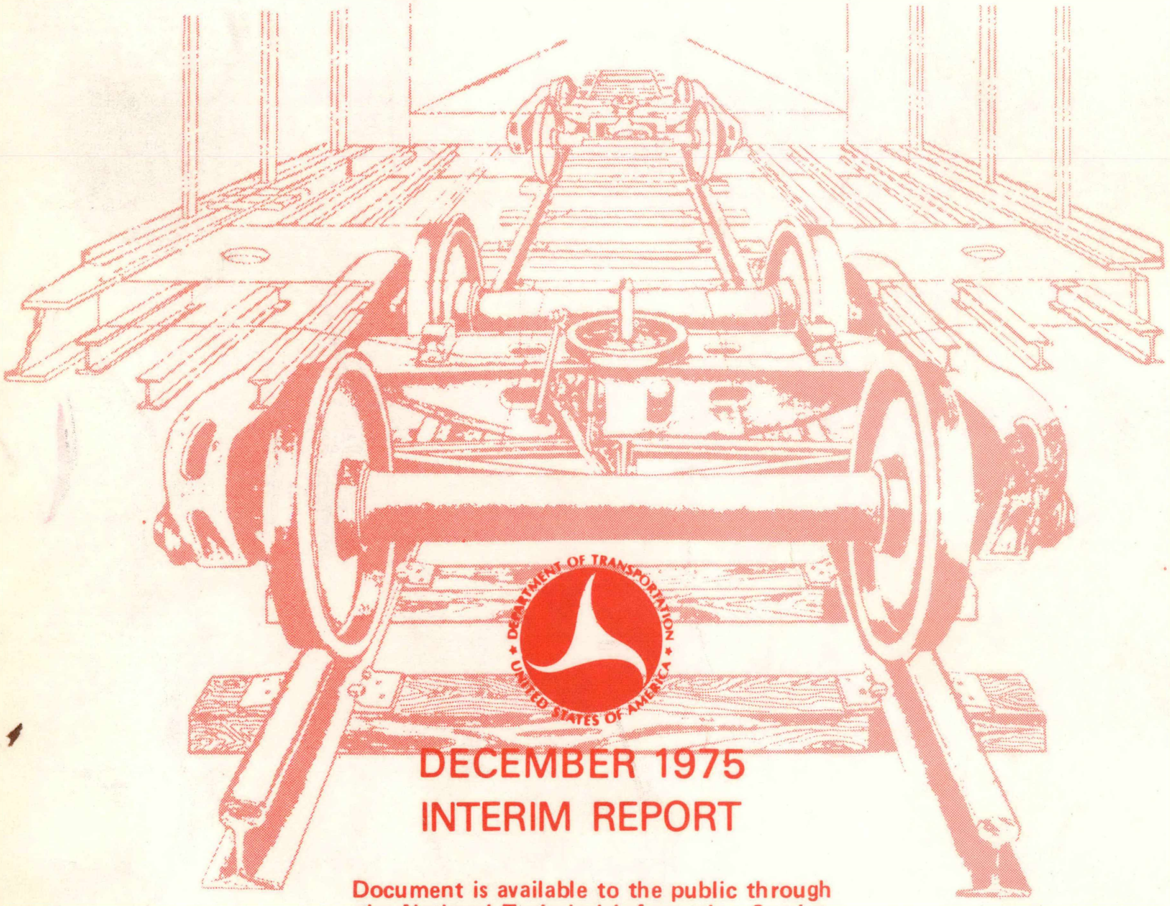
FREIGHT CAR TRUCK DESIGN OPTIMIZATION

SURVEY AND APPRAISAL OF TYPE II TRUCKS

Southern Pacific Transportation Company
Technical Research and Development Group



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16. Abstract

This report serves as an introduction to the family of truck designs known as Type II that will be studied in connection with the Federal Railroad Administration's Truck Design Optimization Project.

An investigation was made of existing trucks and truck designs qualifying as Type II trucks and this investigation considers features which would be of interest in selecting candidates for testing and evaluation of such trucks under Phase II of the Truck Design Optimization Project.

Type II special service designs embody new concepts that utilize current wheel set and journal bearing assemblies and braking arrangements compatible with current air brake systems. Car coupler height is maintained but car body supports other than center plates can be employed. Ride quality and minimum maintenance cost are of major importance to Type II designs.

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~~ASF Ride Control~~

(1) Dresser DR-1

~~Mod. Barber-2~~

(2) Standard Barber-Scheffel

(3) Natural Swing Motion

(4) C-PEP

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Section 1

INTRODUCTION

The scope of Phase I, Task 6.0, covers survey and appraisal of developments in the field of freight car suspension systems that may qualify as Type II trucks and be considered for testing during Phase II of the Freight Car Truck Design Optimization Project.

Many variations of freight car truck design are appearing in both domestic and foreign markets, and it is the purpose of this survey to include appraisal of all existing systems that have features which show a potential for development and incorporation into an improved suspension system. The appraisal will include technical features, feasibility, service experience, availability, and cost factors.

The Type II design can embody new concepts that utilize current wheel sets, journal bearing assemblies, and braking arrangements compatible with current air brake systems. Car coupler height is to be maintained; however, car body supports other than centerplates can be employed. Appraisal is based on features that will provide good ride qualities in a rail car used to carry lading which is sensitive to damage or used under operating conditions that require a higher level of performance than conventional freight car trucks.

Certain improvements to Type I trucks that have a potential for upgrading performance to the extent that they could be considered in the Type II category are also considered in this survey and appraisal.

Section 2

USINES EMILE HENRICOT TRUCK

2.1 TECHNICAL

The development of this truck design was started in Belgium about 1970 by Usines Emile Henricot in an attempt to both improve performance and reduce cost. A photograph of the assembled truck is shown in Figure 2-1.

The three-piece truck, as illustrated in Figure 2-2, is made up of two cast-steel side frames and a cast-steel bolster. Dual-rate, load-carrying springs are located between bolster and side frames. It has a conventional center plate, but is equipped with spring-loaded side bearings. Snubbing is accomplished by spring-loaded friction devices involving levers that link coil springs to pads bearing on the column guides of the side frames.

The unique feature of the design is an elastic connection between side frames and axles. This is accomplished by using a circumferential "axle box" which has two rings of an elastomer between it and the side frame, and separated by a central rib integral with the side frame as illustrated in Figure 2-3.

Steel-to-steel contact is eliminated and a certain amount of restrained flexibility is assured as well as a means of damping out of some of the high-frequency vibrations. The elastomer rings, after being clamped tightly between the axle box, the side frame, and the pedestal cap provide a rigidity between side frames and the axles that holds the truck in tram and prevents parallelogramming. See Figure 2-4.

The outside and inside contours of the rubber rings are eccentric. This allows accurate adjustment of the wheel base during fitup by rotating the rings to the angle required as shown in Figure 2-5. The connection does not require machining of the side frames.

The elastic elements are properly aligned to adjust the wheel base at the initial assembly, and it is not necessary to again make this adjustment during wheel changes, etc., as only the pedestal caps are removed, and the adapters remain secured to the side frame.

The manufacturer makes the following claims for the design:

- A significant reduction in wheel wear
- Increased bearing life
- A decrease in noise level
- A reduction in track maintenance

2.2 FEASIBILITY

The manufacturer states that numerous tests have been run, both in the laboratory and in service, that show the device prevents parallelogramming and provides the advantages claimed. Their research has been completed by study of a mathematical model and by simulation on a digital computer that supports the other test data.

Success of this concept depends entirely on the elastomer and the manufacturer states, "Some precautions are naturally to be taken as to the elastomer quality." No doubt, the composition and manufacturing technique of the elastomer is highly critical.

There is no provision for controlled lateral motion, and the "axle box" clamped to the bearing through the elastomer rings effectively eliminates any appreciable lateral motion between the axle and side frame.

2.3 SERVICE EXPERIENCE

The truck is known as the "Eurospeed" bogie in Europe and was designed for speeds over 120 km/hr. It has had limited service in the Common Market countries and is being promoted for sale in the "developing countries." There have been 14 car sets of the trucks in service from two to five years and 86 car sets for about one year. The truck has not been mass produced.

2.4 AVAILABILITY

Usines Emile Henricot is a steel foundry that has specialized in railroad equipment for many years. They manufacture and sell freight car trucks as well as other railroad equipment throughout the world. Their specialized equipment is also manufactured in other countries under a licensing agreement. They claim to make numerous "after sale" contacts with customers and make engineering followups to enable them to know how their equipment performs in service.

2.5 COST FACTORS

Cost factors are not available. However, design of the truck is such that costs (when manufactured in volume) should be little more than a conventional three-piece truck.

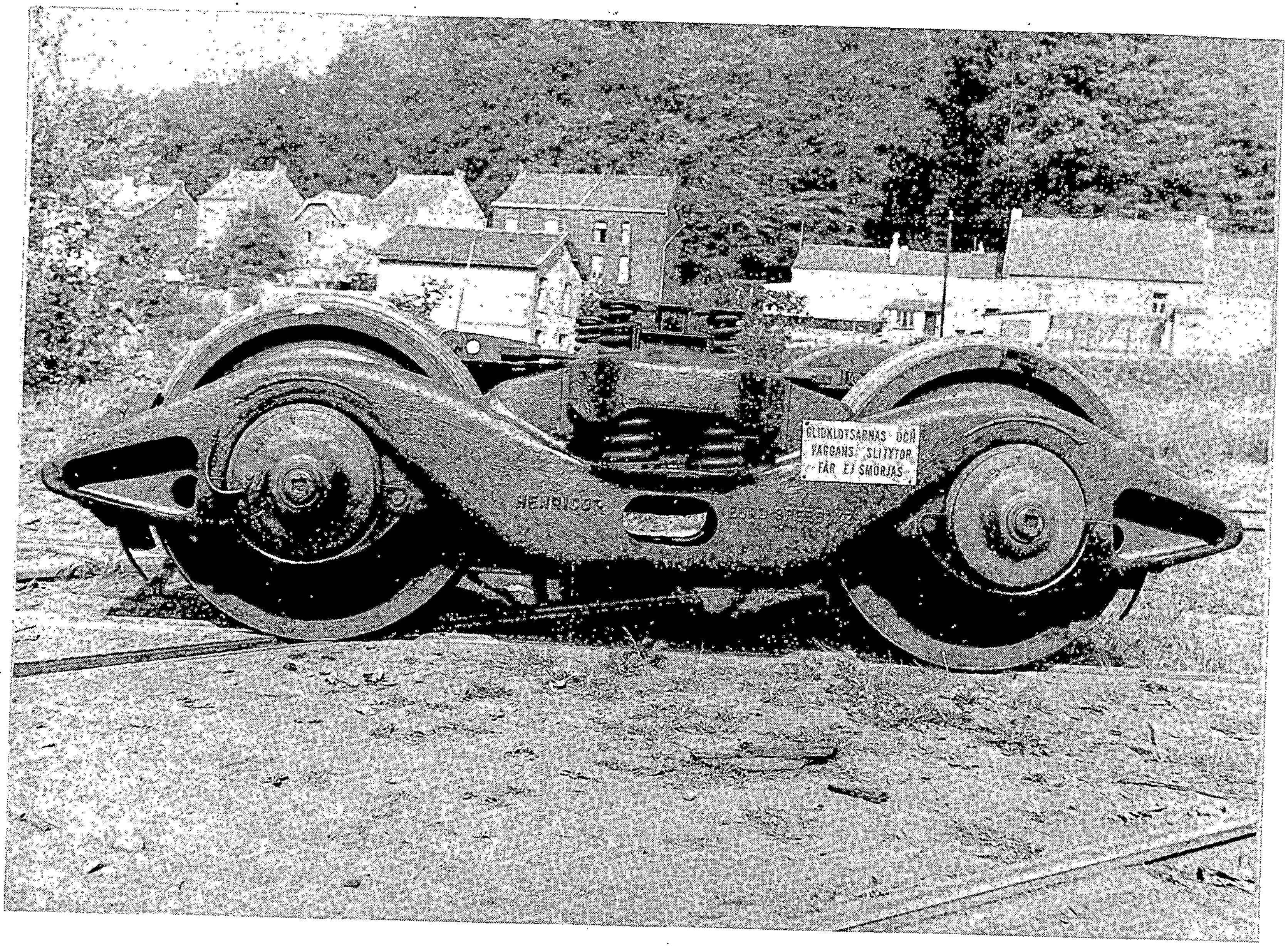


FIGURE 2-1

USINES EMILE HENRICOT TRUCK

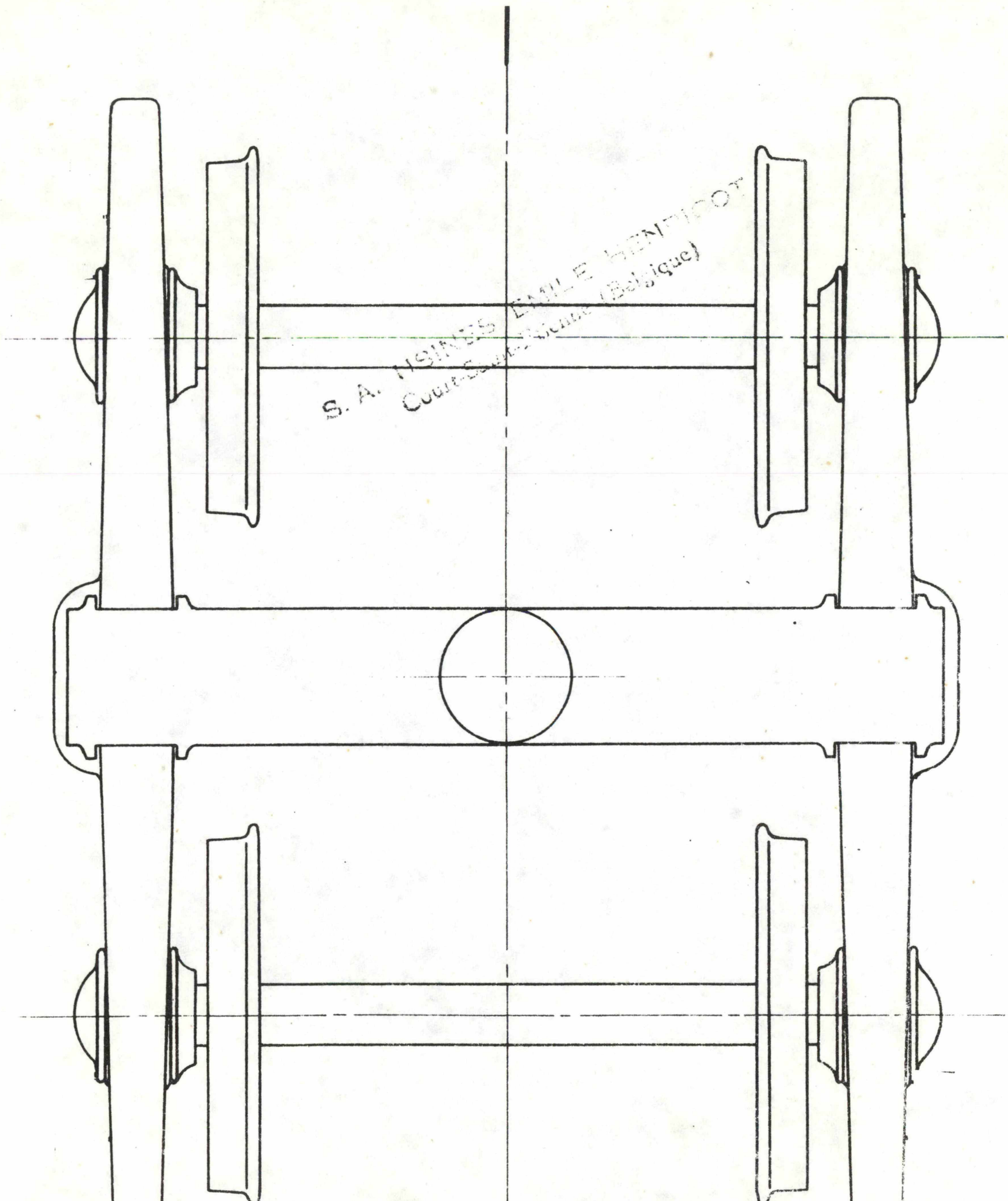


FIGURE 2-2

USINES TRUCK ARRANGEMENT

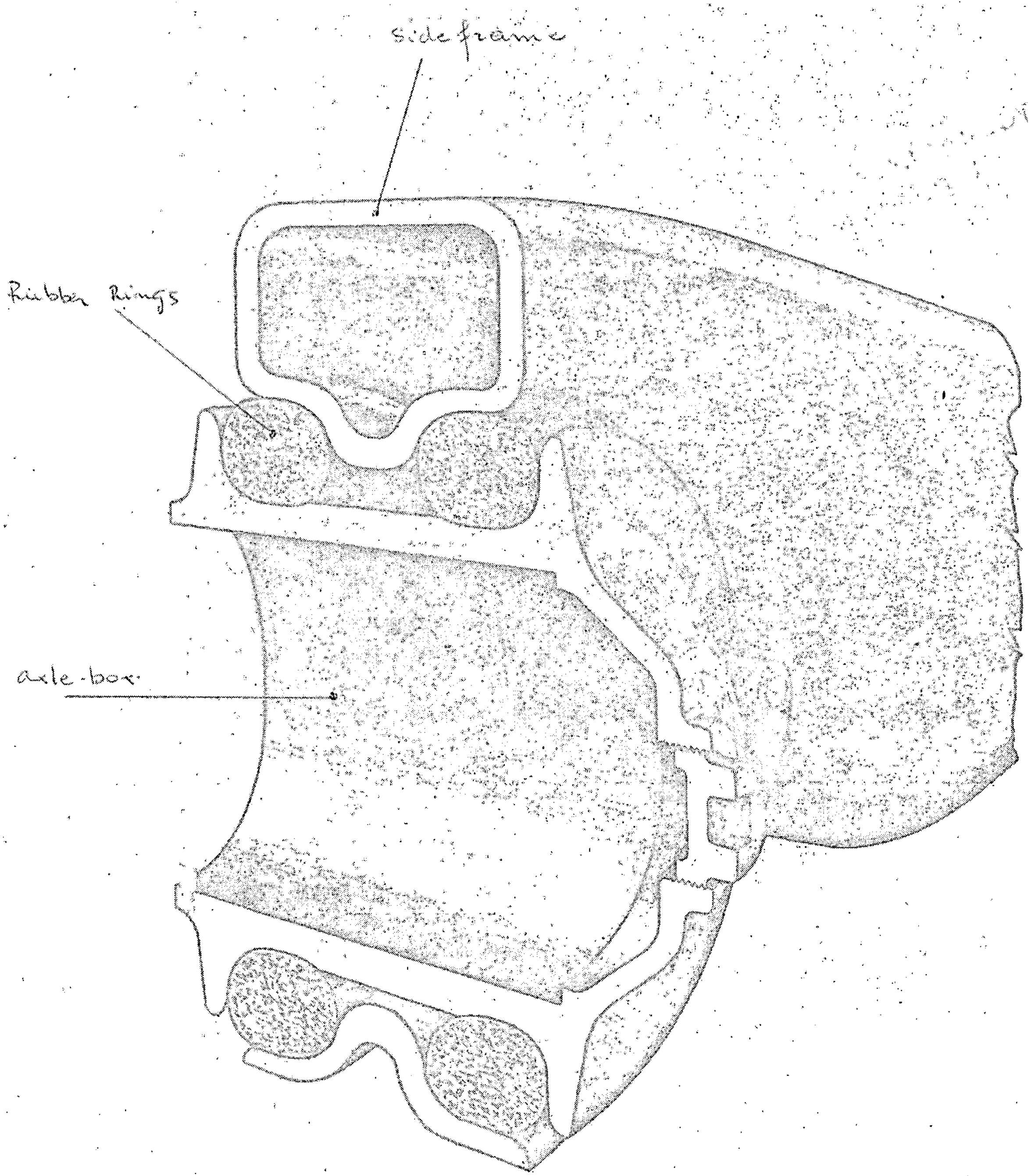


FIGURE 2-3
ELASTIC CONNECTION

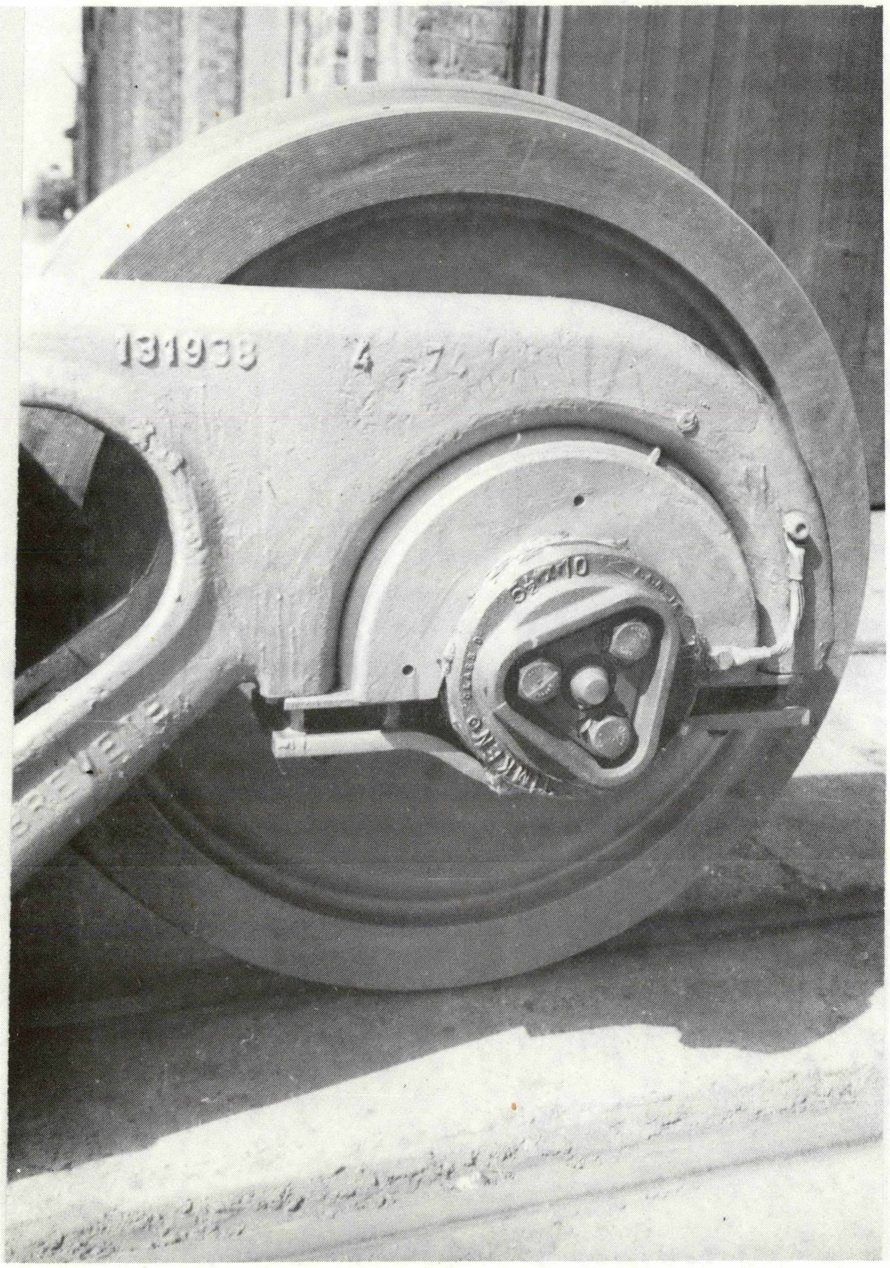


FIGURE 2-4

AXLE BOX ARRANGEMENT

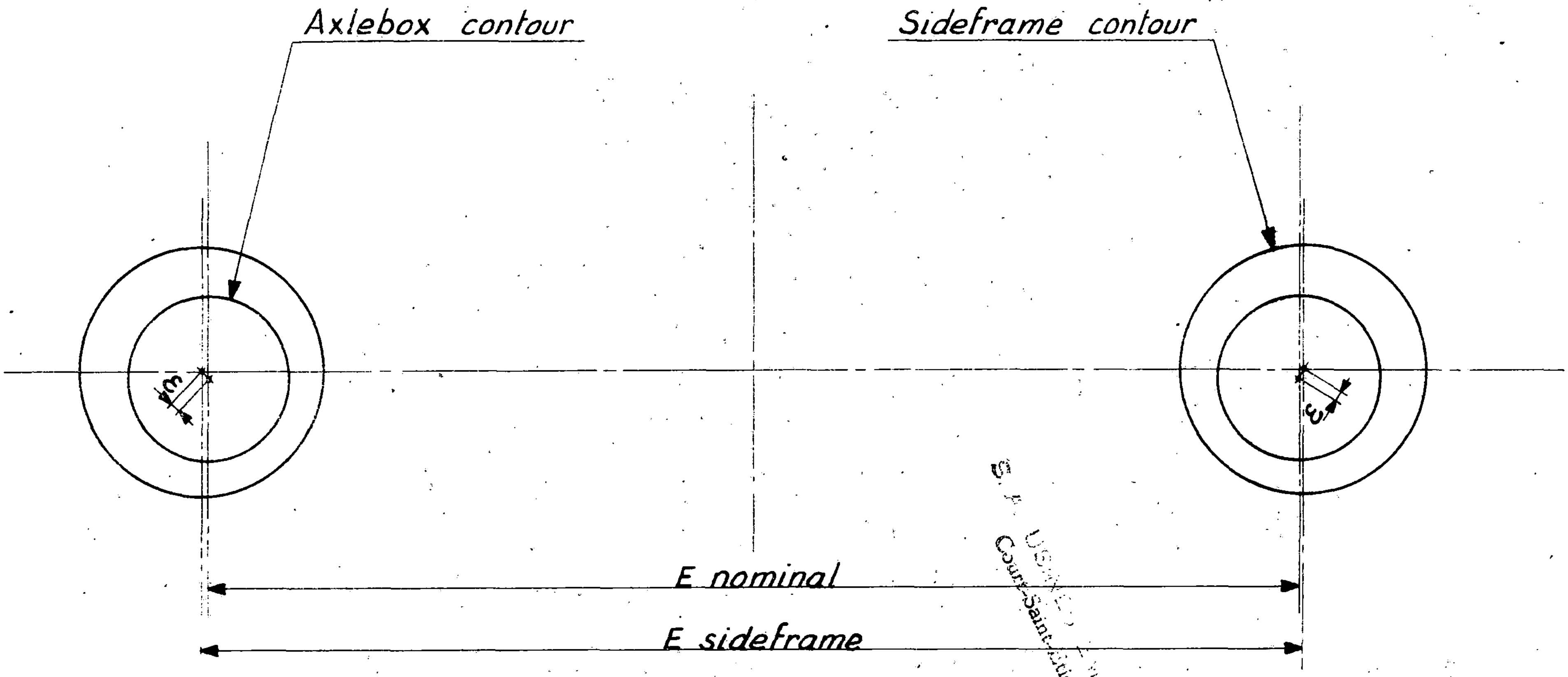


FIGURE 2-5

WHEEL BASE ADJUSTMENT

Section 3

BUCKEYE ELASTO CUSHION TRUCK

3.1 TECHNICAL

The development of this concept by Buckeye Steel Castings Co. of Columbus, Ohio began in 1964 and was first tested on the Quebec Cartier Railroad in April of 1968.

The concept consists of a conventional three-piece truck made up of cast-steel bolster and side frames, with the side frames modified to allow application of an elastomer pad between the roller bearing adapter and top of the side frame pedestal opening. It has AAR nominal truck design dimensions, standard wheels and axles, standard bearings and adapters, conventional friction stabilizing system with standard parts, and conventional brakes. A photograph of the assembled truck is shown in Figure 3-1.

Purpose of the elastomer pad is to provide for lateral motion between the axle and side frame, thereby reducing lateral forces at the rail and the car body. The manufacturer considers it "controlled" lateral motion because of the force required to distort the pad in shear and its consequent restoring force. The design provides for 1 in. total lateral movement of the axle on 70-ton trucks and 3/4 in. on 100-ton trucks. An elastomer pad is shown in Figure 3-2.

The manufacturer makes the following claims for the device:

- Reduces wheel flange to rail lateral impact
- Reduces wheel to rail vertical impact forces
- Improves curve negotiability
- Reduces tendency for "rock and roll"
- Reduces wheel flange wear

3.2 FEASIBILITY

The trucks have been service tested for the past six years in numerous types of service with no adverse effects as far as safety is concerned. They have been performance tested by various railroads with regard to truck hunting as well as for their effect on wheel-rail lateral and vertical load reactions. Following are some of the roads that have run tests on the device:

- Quebec Cartier Railroad
- Bessemer & Lake Erie
- Burlington Northern
- Seaboard Coast Line
- Union Pacific
- Trailer Train

These tests generally indicate that the device does have an appreciable effect on lateral forces and some effect on truck hunting. As long as the bonds between the elastomer and the top and bottom plates are not broken, the pads will remain serviceable. It is estimated from service testing that life of the pads is between 300,000 and 400,000 miles, depending upon the type of service.

3.3 SERVICE EXPERIENCE

Approximately 1,100 car sets are in service, practically all 100-ton-capacity trucks. Bessemer & Lake Erie, Burlington Northern, and Trailer Train are using the device in service quantities. In February, 1974, two Burlington Northern cars were inspected after approximately 275,000 miles. Wear in pedestal legs, pedestal roofs, bolster center plates, body center plates, and roller bearing adapters was noted and compared to companion cars with standard trucks. The Elasto-Cushion trucks were Barber S-2 models and the standard trucks were ASF A-3 models.

This inspection indicated that the following trends seem to be appearing:

- Wear in the pedestal legs, both inboard and outboard, is the same in the Elasto-Cushion trucks as in standard trucks of the same design.
- Wear on the truck center plates and body center plates is also about the same as with standard trucks of the same design.
- Wheel life and roller bearing adapter life seem to be considerably improved for the Elasto-Cushion trucks.
- Bolster gib wear is about the same on both trucks.
- The Elasto-Cushion pads afford a flat surface to bear against the pedestal roof and seem to eliminate pedestal roof wear. They also minimize wear on top of the roller bearing adapters.
- Elastomer pads show some wear, but are still in serviceable condition at 275,000 miles.

3.4 AVAILABILITY

All truck parts except the elastomer pads and the side frames are conventional design and should be available from present sources. Composition and manufacturing techniques are, no doubt, critical on the elastomer pads. In addition, the truck concept is patented; however, there should be no problem with availability.

3.5 COST FACTORS

The approximate first cost differential for Elasto Cushion trucks compared to standard trucks is $450 per car set. The elastomer pads add another item of maintenance; however, reduction in wheel wear and adapter wear should be offsetting, and it is estimated that there will be little difference in maintenance costs in the remaining truck parts.

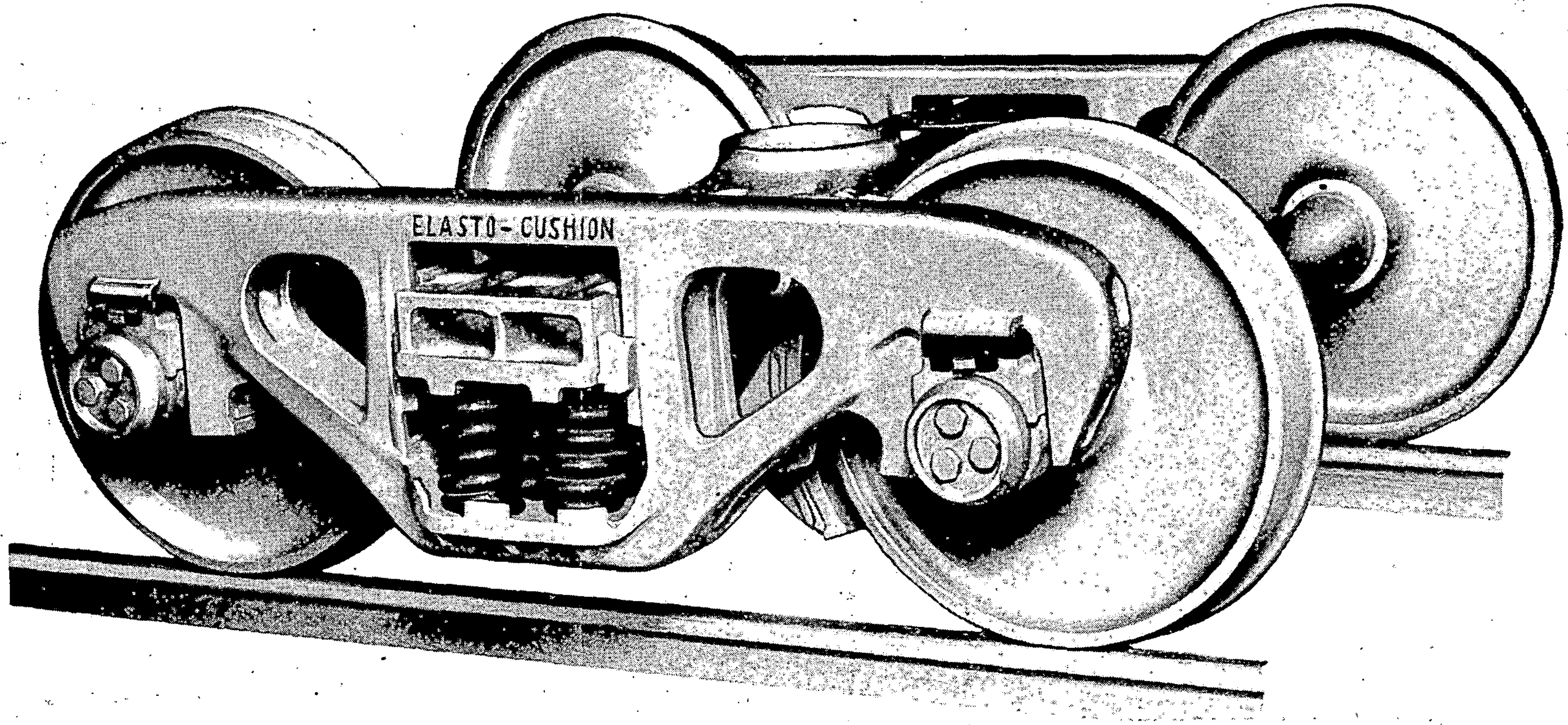


FIGURE 3-1

BUCKEYE TRUCK ARRANGEMENT

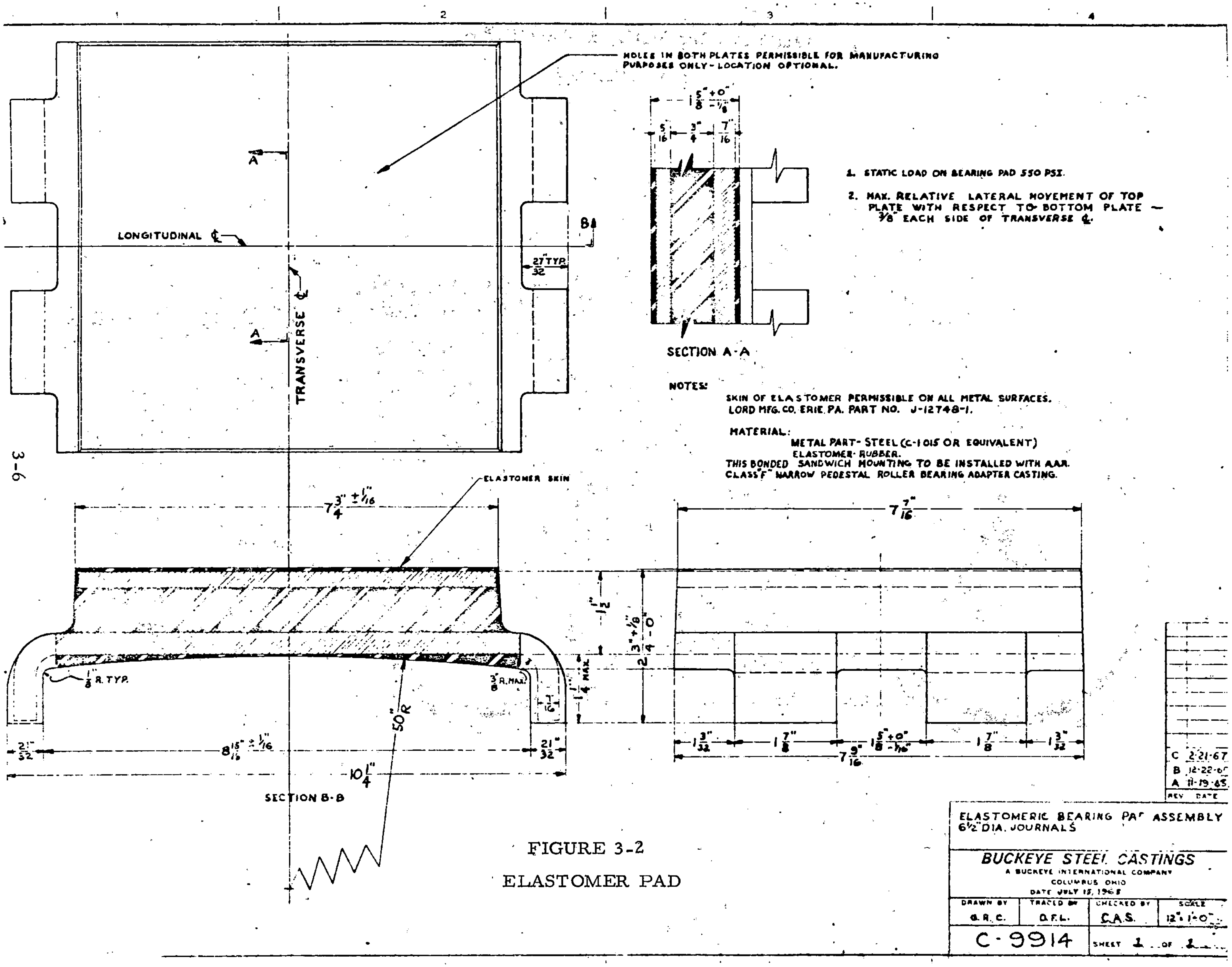


FIGURE 3-2

ELASTOMER PAD

Section 4

SUMITOMO TRUCK

4.1 TECHNICAL

As a result of an extensive investigation conducted by the Japanese National Railway in 1970 on performance of the conventional freight car truck used in the United States, the Sumitomo Metal Industries of Osaka, Japan developed a proposal for their concept of a Type II truck. This proposal was submitted to Southern Pacific Transportation Company in July of 1973.

The most significant feature of their proposal is that it utilizes an air spring in a secondary spring arrangement. Figure 4-1 shows photographs of trucks used on one of their electric railways which depicts a "Sumiride" air spring of a similar type to that proposed. The Sumitomo freight car truck concept, however, uses the air spring between the bolster and side frame with a somewhat conventional side bearing located on center line of bolster and center line of truck side frames. Weight of the car is carried through a center plate in a conventional manner. A diagram of the Sumiride air spring is shown in Figure 4-2.

Primary springing consists of coil springs over each axle box with precompressed elastomer pads on both sides of the box.

Wheels, axles, and roller bearings are AAR standard for use in the United States. Wheel base is 6 feet 6 inches and the transverse distance between center line of journals, coil springs, air springs, side bearings, and side frames is also 6 feet 6 inches. Estimated weight of the two trucks is 23,400 lb. The proposal is based on a 70-ton, nominal-capacity truck. Truck arrangement is shown in Figure 4-3.

The complete truck frame consists of two side frames and a cross tie. The side frames are fabricated type, integrated with the pedestal, and having seats for air spring and cross tie as well as brackets for lateral damper and brake guide. The cross tie connects both side frames tightly to maintain squareness of the truck, but is flexible in torsion to prevent the tendency of uneven loading on the wheels. The design contemplates fabricated side frames, but they could be mass produced in cast steel. The bolster is fabricated type, but can also be of cast steel. It is designed with seats for center plates and side bearings as well as brackets for an antiroll device, lateral damper, lateral bumpers, bolster anchors, and leveling valves. Internal spaces at both ends of the bolster are utilized for auxiliary air reservoirs for the air springs. An elastomer stop is provided in the air spring so that in the event of air pressure failure, the weight is still supported (with minimum cushioning).

An antiroll device is provided consisting of two sets of torsional springs in parallel with the secondary (air) springs. Calculations indicate that natural frequency of the rolling tendency is increased by a factor of 2 by the antiroll device.

Two leveling valves are installed in each truck between the bolster and side frame in parallel with the air springs that automatically regulate the variations of height caused by increase or decrease of the load, thereby maintaining constant height of the air spring at all times. The leveling valve is designed to be relatively insensitive to dynamic change of load due to external factors.

A pressure-balancing valve is fitted between the auxiliary air reservoirs of the left and right air springs in order to equalize the internal air pressures within a set value so that the car body will not list excessively should one air spring lose pressure.

An air supply for the air springs will be a significant problem in this design and it is contemplated that in the event that test runs are made, the test car would be close to the locomotive and air could be supplied from the brake system. Sumitomo contemplates an electric-driven air compressor mounted on each car as an air supply for future applications in regular service.

The brake system is reasonably conventional, utilizing a truck-mounted brake. The system is modified in order to allow for deflection of the primary springing by providing for the brake shoe head to rotate around the brake beam so that the shoe can face the wheel tread. Excessive rotation is prevented by a spring placed between the shoe head and brake beam. Brake beams are carried by the side frames in guide slots in a conventional manner.

The design also provides for disk brakes as an alternate. In this arrangement, the brake disks are installed through a hub mounted on the axle and the brake cylinders are a diaphragm type.

4.2 FEASIBILITY

The design appears to be mechanically feasible as most features have been used or tested separately in other truck applications. The air spring has been used in Japan and elsewhere on passenger car applications with success; however, feasibility of its use in general freight car service in the United States is open to question. Making an air supply available for the air spring would seem unduly complicated and costly for freight service.

4.3 SERVICE EXPERIENCE

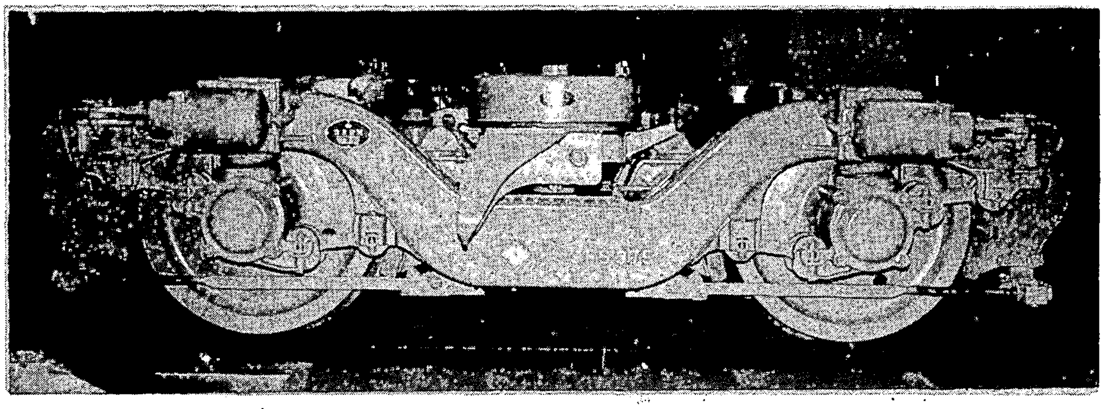
There has been considerable service experience on the "Sumiride" air spring as well as other features of the design in Japan on passenger cars; however, this is a "design proposal" and has no service experience.

4.4 AVAILABILITY

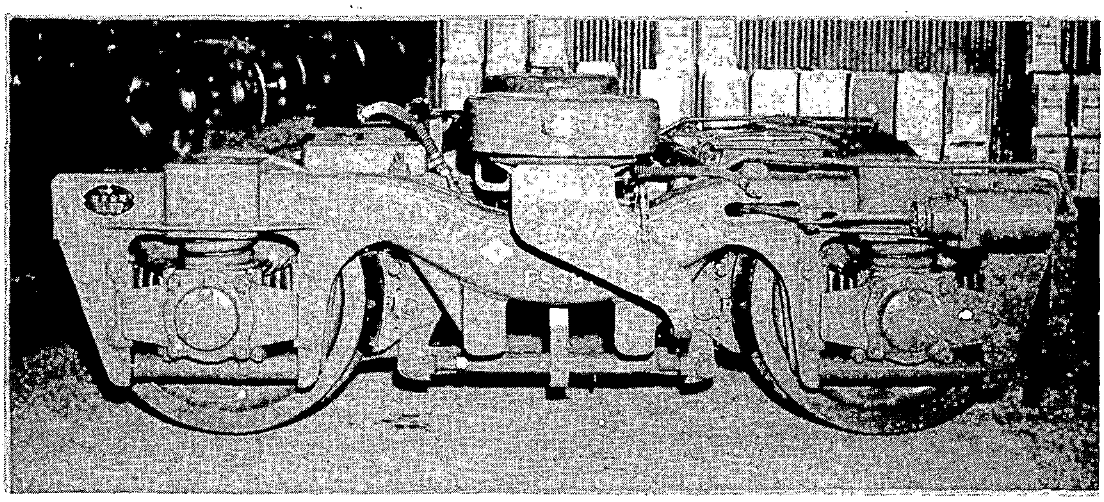
Air springs are available in Japan as well as domestically, and there is nothing about the remaining parts of the design that could not be manufactured with conventional tooling now available. Test trucks would be custom-made as parts other than wheels, axles, roller bearings, and air springs are not available in the configuration required.

4.5 COST FACTORS

Sumitomo Metal Industries has quoted Southern Pacific Transportation Company (SPTCo.) a figure of $92,000 for development of this concept. This includes dies, molds, etc.; cost of design; cost of testing at Sumitomo and Japanese National Railways (JNR); and delivery of two truck sets for testing in the United States. An estimated cost of the truck in production has not been furnished; however, it appears that the cost would be at approximately the same level as the so-called "express" trucks in the United States.



AIR SPRING TYPE FS-375



AIR SPRING TYPE FS-381

FIGURE 4-1
SUMITOMO AIR SPRING TRUCKS

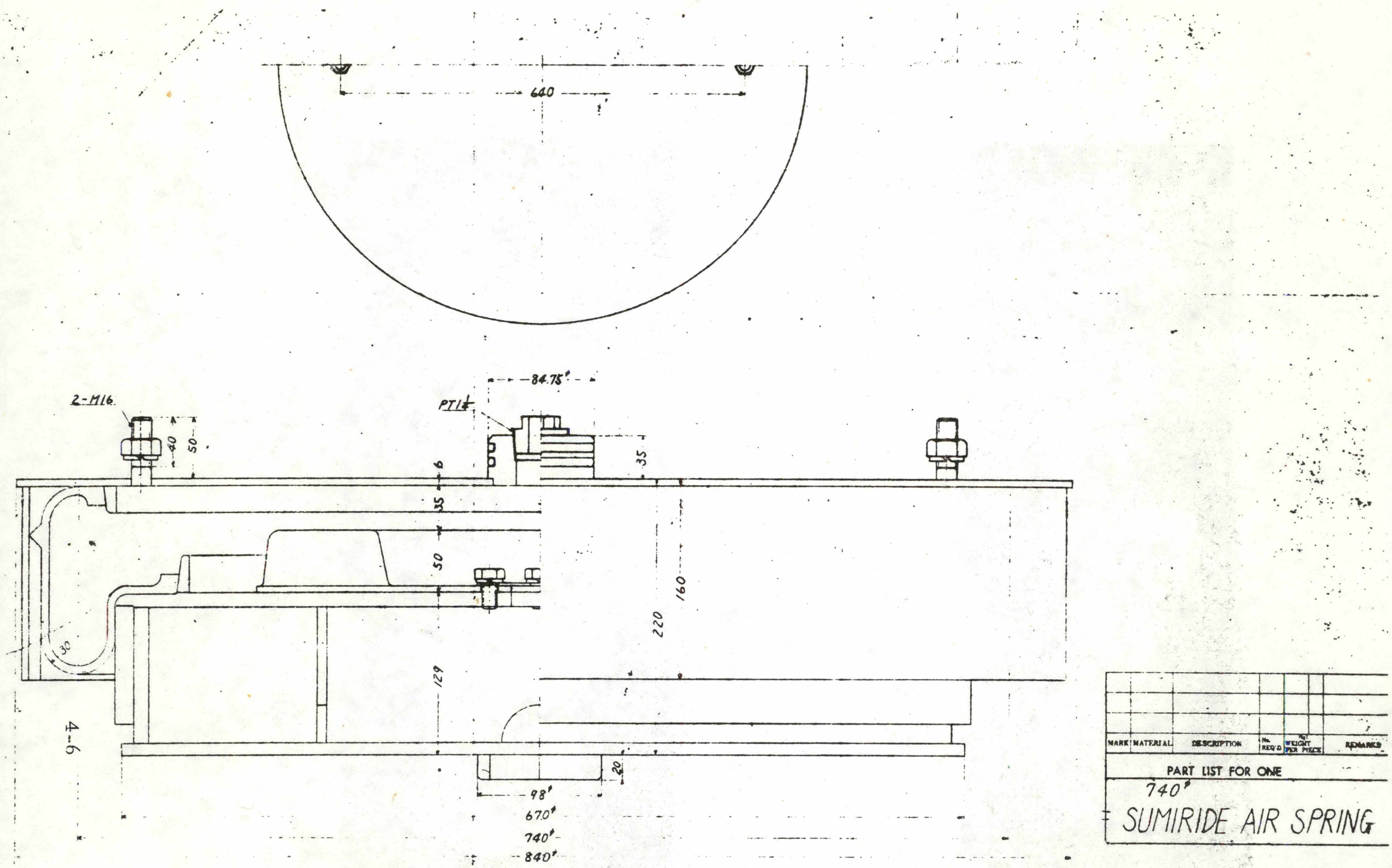


FIGURE 4-2

AIR SPRING

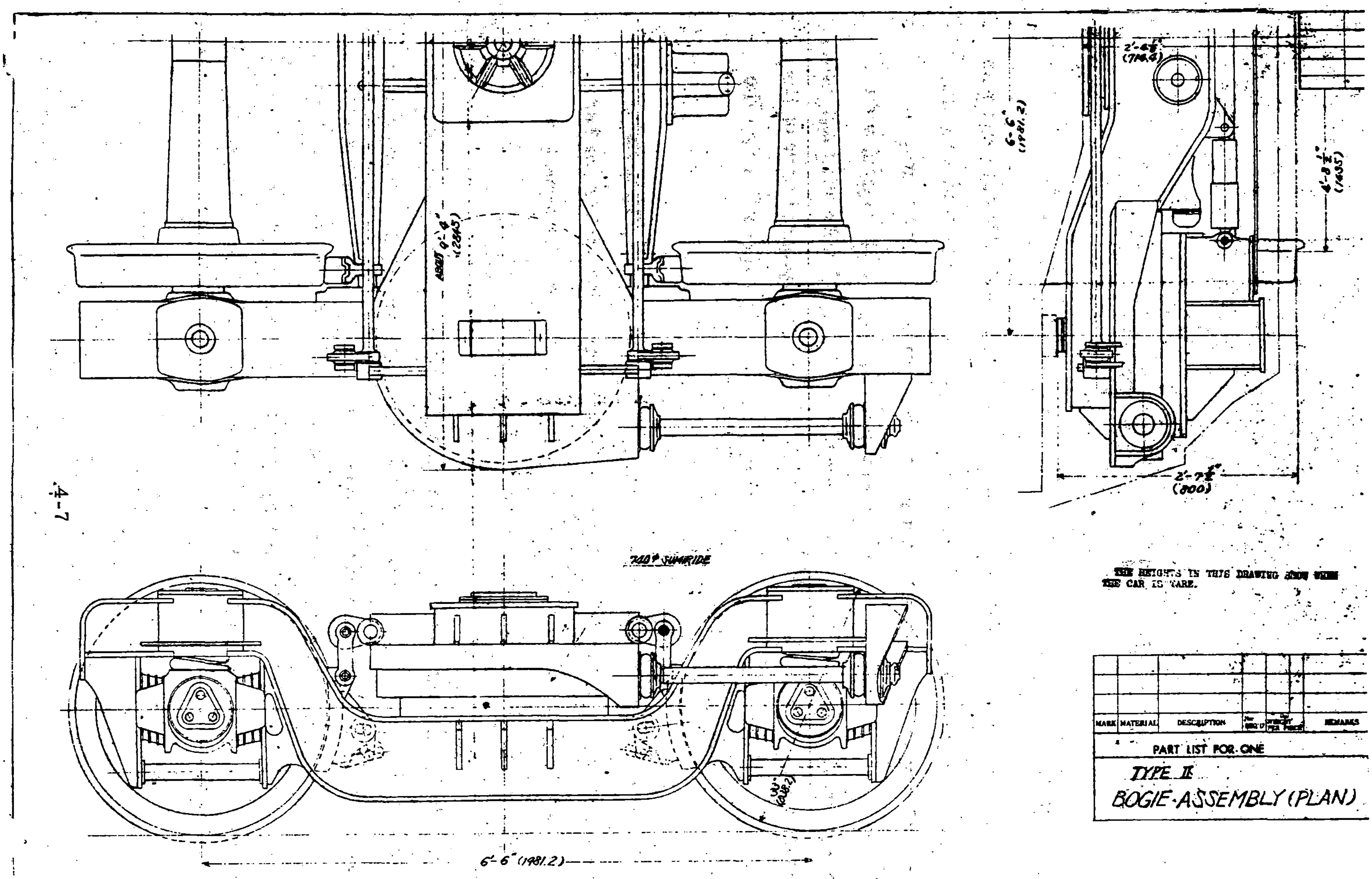


FIGURE 4-3

TRUCK ARRANGEMENT

Section 5

AMERICAN STEEL FOUNDRIES T-11 SUSPENSION SYSTEM

5.1 TECHNICAL

The ASF T-11 Suspension System is offered in 100-ton capacity only and was developed to provide a greater reserve capacity in the suspension, control truck hunting and minimize the rock and roll problem with high center of gravity hopper cars. It is a three-piece arrangement with cast-steel side frames and bolster. Wheels, axles, bearings, adapters, brake rigging, etc., are conventional. Snubbing elements are special and an integral part of the improved suspension. Layout of the system is shown in Figure 5-1 and the assembly in Figure 5-2.

The major features in the system are that it is equipped with "Simplex" constant-contact side bearings and longer travel springs. In addition, it has improved snubbing action, pedestal liners, more positive securement of friction plates, and 16-inch diameter center plate.

The Simplex side bearing is designed to help control vertical motion at the side bearing and reduce "rock and roll," as well as provide constant contact for a damping action as a deterrent to unstable hunting. The Simplex side bearing is made for application to the truck bolster in place of a conventional double roller side bearing. It is designed to use the working parts of two Simplex snubbers of the type that were used successfully for many years in the spring cluster of conventional trucks before built-in snubbing devices came into general use. The side bearing is shown in Figure 5-3.

Rock control is obtained by dissipating the kinetic energy of the body rocking on the truck bolster center plate and by cushioning the motion of the body to prevent heavy impact blows which promote wheel lift and structural damage. With a snubbing action at the side bearing, normal action of the truck springs and snubbing elements is not affected, permitting the main truck suspension to better perform its intended function of providing an acceptable vertical ride.

The snubbing unit maintains contact with the body side bearing at all times and when the body rocks to one side, the unit on that side is compressed against friction snubbing while the unit on the other side extends to follow the body side bearing. At the extreme rock condition, the body stops moving and reverses direction. At that time, the unit on the far side begins to be compressed against friction snubbing as the body rocks toward it and the unit which has been compressed begins to extend following its body side bearing. This sequence of alternate compression and extension continues as long as the body is rocking, with kinetic energy being dissipated with each stroke by friction elements in the side bearings. The rock control action sequence is shown in Figure 5-4 and a typical load deflection curve in Figure 5-5.

The original longer travel springs (4-5/16 inch) were designed and tested for identified reserve energy requirements and these characteristics have been incorporated in the new AAR D-7 spring. The present generation of T-11 suspensions will use the D-7 spring. The benefits of the increased ability to absorb energy within the suspension system are the elimination, or at least a reduction, of the number of oversolid spring excursions and a reduction in the number, as well as magnitude, of vertical accelerations. Coupler height range from a light to loaded car, as compared to conventional trucks with D-5 springs, increases approximately 1/4 inch.

Use of the Simplex constant-contact side bearing, in addition to vertical damping, also provides a rotational restraining force designed to control excessive truck swivel. This reduction of swivel or hunting results in a consequent reduction of harsh contact between wheel flanges and the rail and an improvement in the lateral ride. This, in turn, reduces flange wear and decreases derailment tendencies. Manufacturer's tests indicate a vertical ride improvement with a loaded car of 150 percent and a lateral ride improvement of 300 percent with an empty car.

The manufacturer claims the following advantages for the T-11 Suspension System:

- Less damage to lading
- Longer car body life
- Less wear on all truck parts
- Reduced damage to track

5.2 FEASIBILITY

Numerous tests were run,using the ASF test train,on various railroads and at the Ground Transportation Test Center in Pueblo and it has demonstrated no unstable characteristics. It is also approved by the AAR for application to sensitive cars to control "rock and roll." There is nothing unconventional or untried about this approach and it is entirely feasible.

5.3 SERVICE EXPERIENCE

There has been extensive testing of this design and as of November 1974, there were approximately 2,000 car sets in service. ASF Service Engineering people have a continuing inspection program of the T-11 systems in service to develop a history. These observations, together with customer reports, indicate nothing of an adverse nature developing to date. Wheel inspections are being conducted at periodic intervals, but time in service has not allowed for development of positive data. Car and truck stability seem to have been accomplished in service and predicted improved life of components seems accurate based on early data.

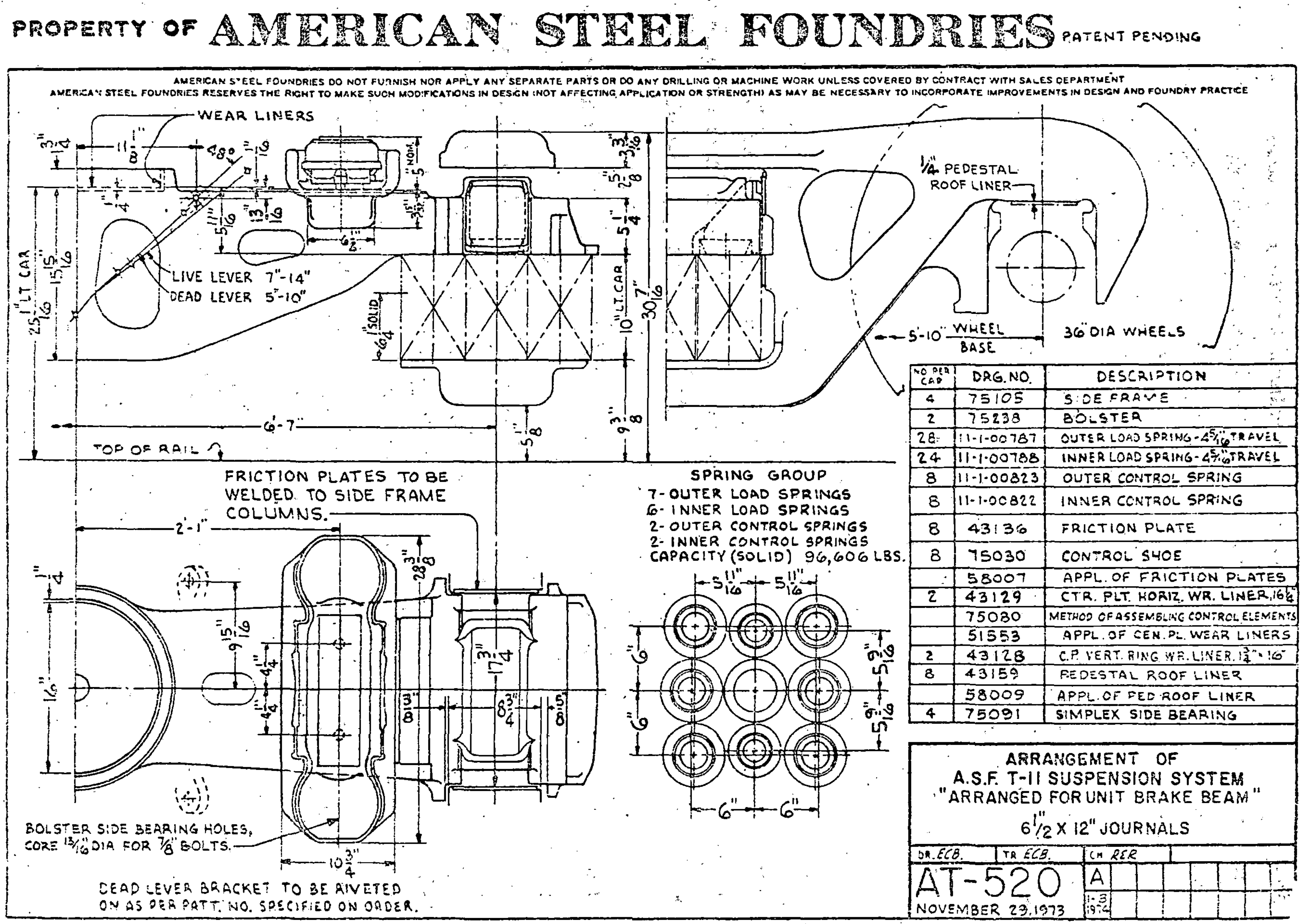
5.4 AVAILABILITY

The system was developed and is manufactured by American Steel Foundries and the major parts are cast steel. There should be no problem in obtaining special items such as the Simplex side bearing from ASF.

5.5 COST FACTORS

The system as described herein has a present first cost 23 percent higher than conventional trucks having 3-11/16 inch spring travel. ASF also offers the basic truck design (4-1/4 inch spring travel and the T-11 snubbing elements) with options as to added devices at 1-1/2 percent over their conventional trucks.

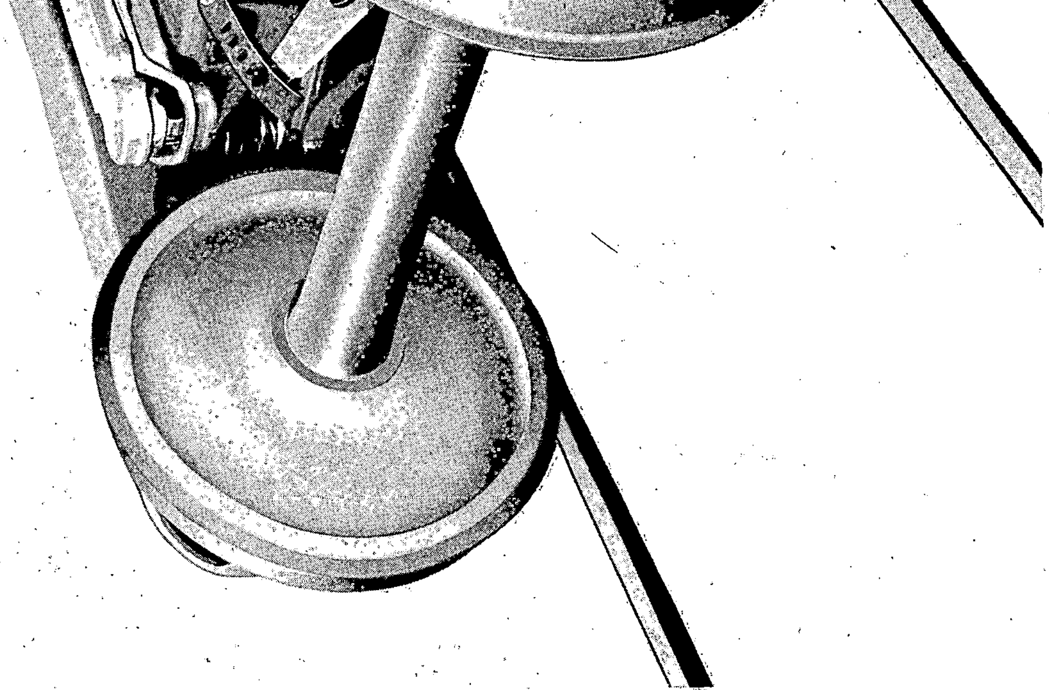
One of the major design criteria for this concept was to provide improved component life and they have provided a 16-inch diameter center plate with improved rim design, improved application of friction plates, pedestal liners, and improved cast-steel friction shoes, all of which should result in reduced maintenance costs. In addition, improved performance, such as reduced hunting, etc., should result in a corresponding reduction in wheel wear and general truck and car body deterioration, which would be reflected in reduced maintenance cost.



NO PER CAR	DRG. NO.	DESCRIPTION
4	75105	SIDE FRAME
2	75238	BOLSTER
28	11-1-00787	OUTER LOAD SPRING - 4 5/16" TRAVEL
24	11-1-00788	INNER LOAD SPRING - 4 5/16" TRAVEL
8	11-1-00823	OUTER CONTROL SPRING
8	11-1-00822	INNER CONTROL SPRING
8	43136	FRICTION PLATE
8	75030	CONTROL SHOE
	58007	APPL. OF FRICTION PLATES
2	43129	CTR. PLT. HORIZ. WR. LINER, 16 1/4"
	75080	METHOD OF ASSEMBLING CONTROL ELEMENTS
	51553	APPL. OF CEN. PL. WEAR LINERS
2	43128	C.P. VERT. RING WR. LINER, 1 3/4" x 16"
8	43159	PEDESTAL ROOF LINER
	58009	APPL. OF PED. ROOF LINER
4	75091	SIMPLEX SIDE BEARING

FIGURE 5-1

TRUCK ARRANGEMENT T-11



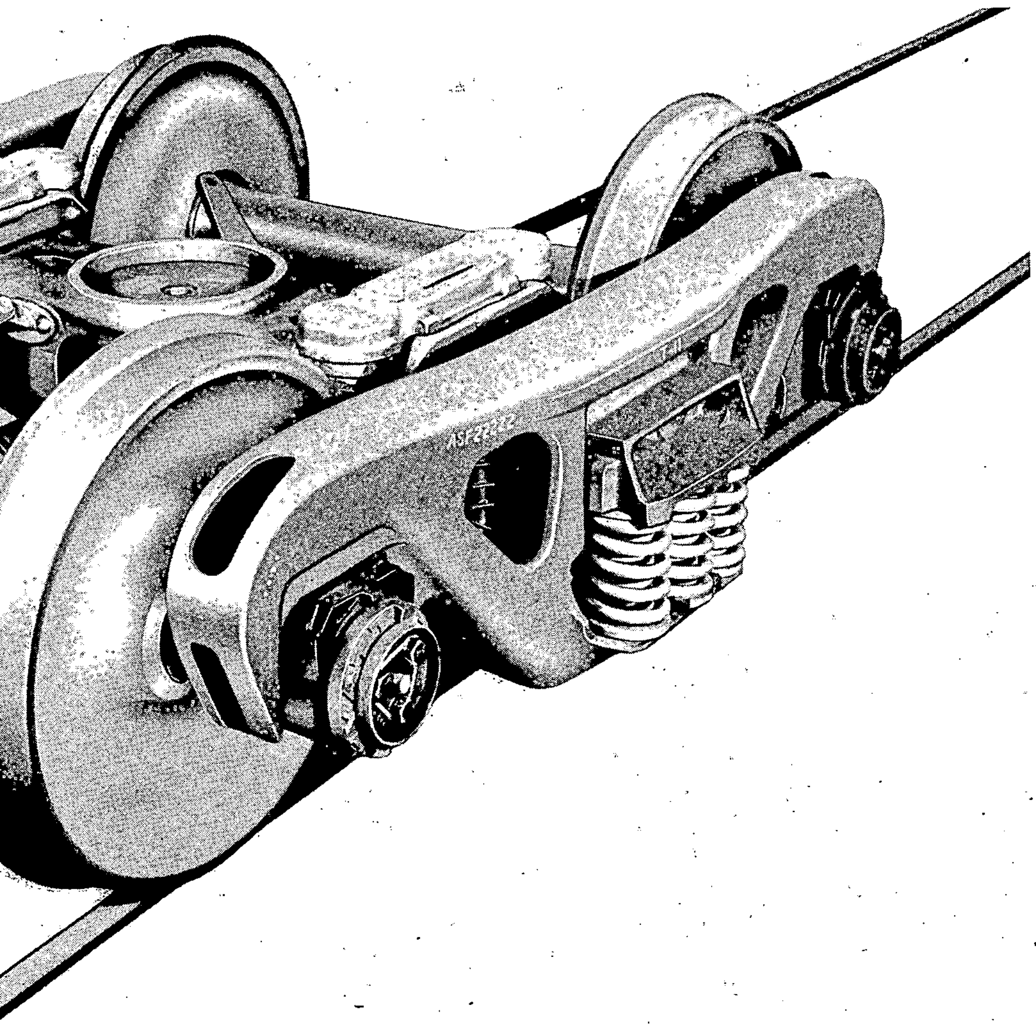


FIGURE 5-2
A.S.F. T-11 TRUCK

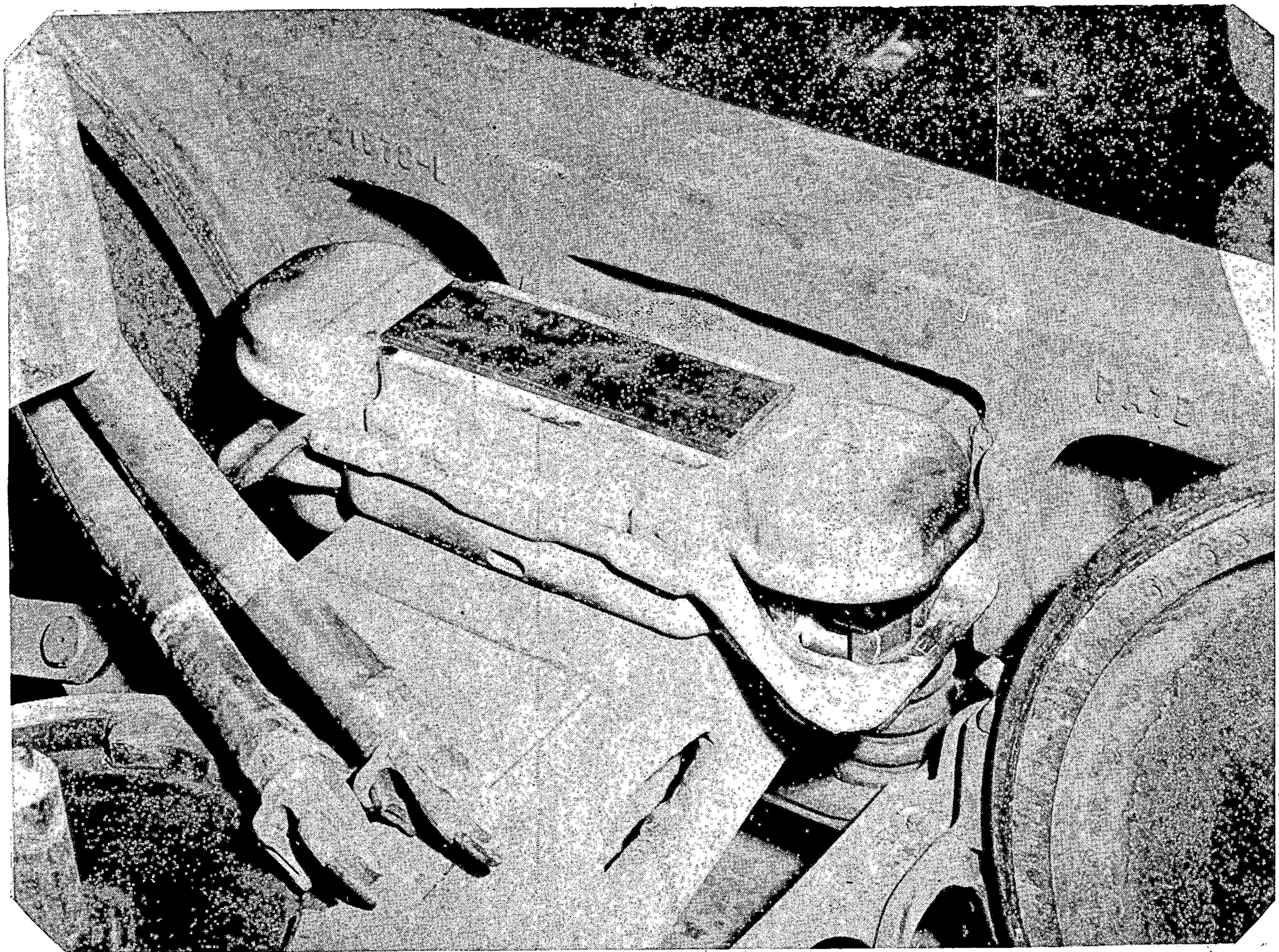


FIGURE 5-3
SIMPLEX SIDE BEARING

OFFICE OF RESEARCH AND DEVELOPMENT

January 16, 1979

Mr. Brian T. Scales
J. P. Devine MFG. Co.
100 Forty-Ninth Street
& A.V.R.R.
Pittsburgh, PA. 15201

Dear Mr. Scales:

Per our latest conversation, I have enclosed herewith the material Wyle Laboratories used in the last TDOP In-Progress-Review last month. I have also instructed them that your name be added to the mailing list of future meetings of such nature.

Your comments and suggestion on the TDOP program are mostly appreciated.

Sincerely,

S/

N. Tsai

Enclosures

cc: RRD-1, w/o encl.
RRD-11, Reading File w/o encl.
RRD-11, Official File ( ) w/o encl.
NTSAI:dp:RRD-11:1-16-79

OFFICE OF RESEARCH AND DEVELOPMENT

January 22, 1979

Mr. Jack Bichsel
Truck Experiment Manager
Director of Mechanical Services
Burlington Northern
176 East 5th Street
St. Paul, MN 55101

Dear Mr. Bichsel:

I am enclosing the latest version of the TDOP Phase II Wear Data Collection Plan and a brief comparison of TDOP/FAST measurements for your review. Of particular interest to us is the planned FAST experiments on radial trucks.

By copy of this letter I would like Mr. S. Guins to supply comments also. We hope continued exchange of this nature will enable us to achieve maximum benefit for both TDOP and FAST programs.

Sincerely,

S/

N. Tsai

Enclosure

cc: S. Guins, TTC/AAR w/enclosure
G. Bakken, Wyle w/o enclosure
P. Olekszyk, RRD-11 w/o enclosure

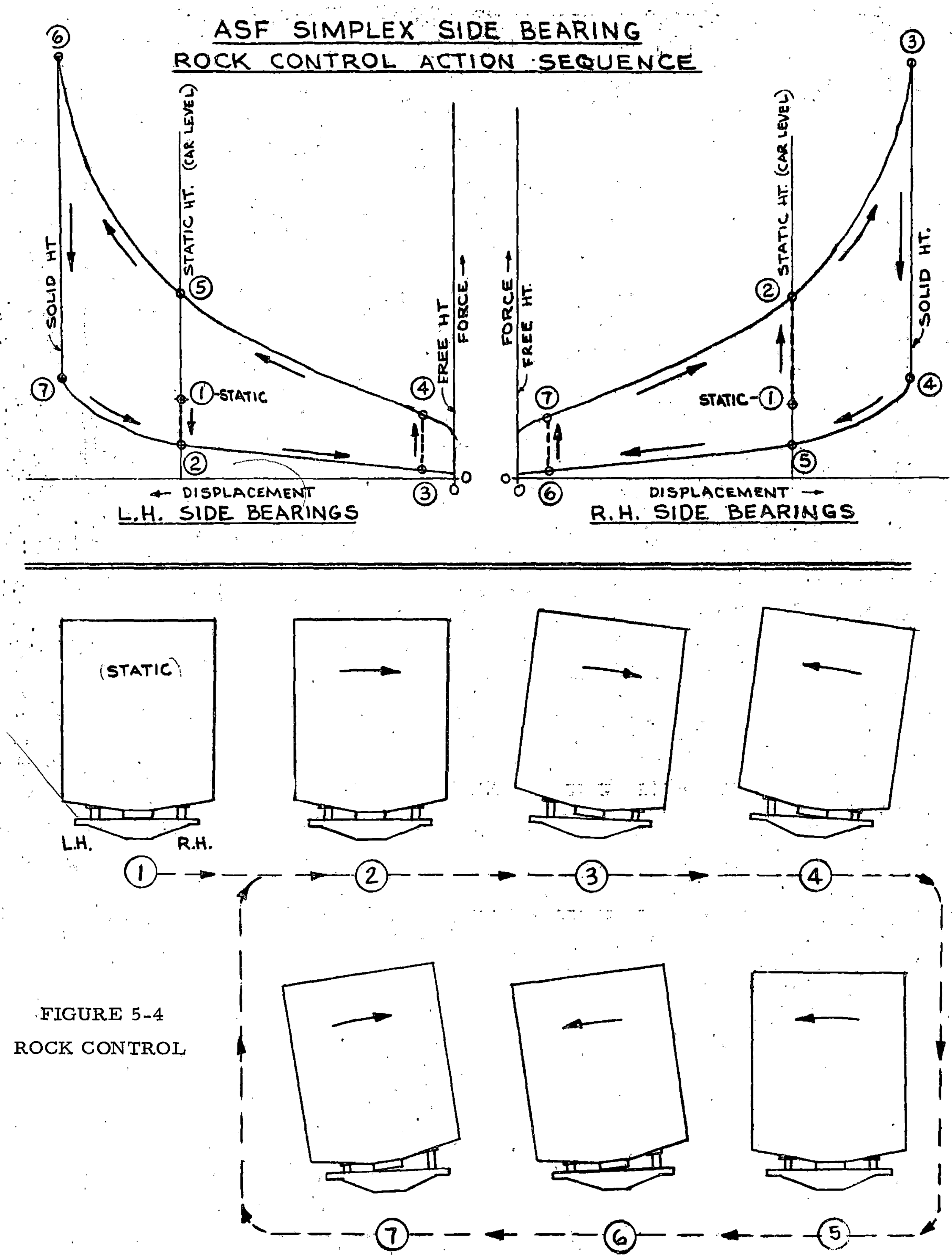


FIGURE 5-4
ROCK CONTROL

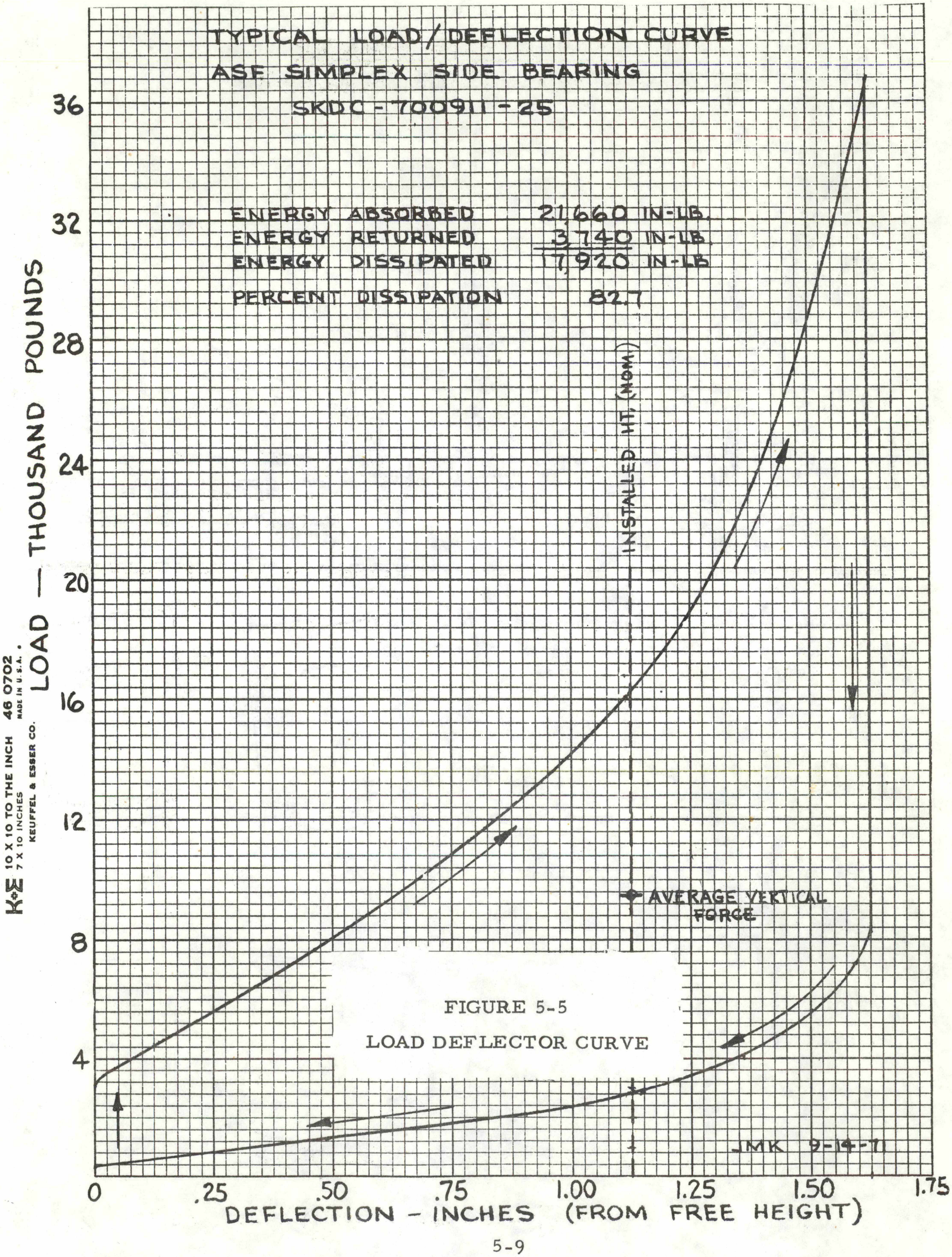


FIGURE 5-5

LOAD DEFLECTOR CURVE

Section 6

CANADIAN PACIFIC - HYDRAULIC INTERBOGIE COUPLING DEVICE

6.1 TECHNICAL

In 1972, Canadian Pacific initiated a study to assess methods to alleviate accelerated wheel flange wear (65,000-70,000 miles of wheel life) being experienced on their "bathtub" unit train coal cars.

They decided to test a "hydraulic interbogie coupling device" of Swiss manufacture, designed to interconnect two rigid trucks on the same car in such a manner as to align the trucks more effectively on curves. The purpose of this device was to reduce wheel flange and rail wear by lowering the flange forces and reducing the striking angle (angle of attack) during curve negotiation. This hydraulic interbogie connector is similar in concept to the mechanical interbogie connectors in use on many European locomotives. If the concept proved to be successful, it was envisaged that it could be used in special applications, provided it could be economically justified.

This steering device was designed for use with rigidized (stabilized) trucks that would not "parallelogram": therefore, before embarking on a test of the Swiss device, it was necessary for Canadian Pacific to develop an effective and safe method of stabilizing conventional trucks to hold them rigidly in tram.

They developed two designs of the same general type stabilizer. One was called the "Saddle Plate Stabilizer," shown in Figure 6-1, and the other was the "Gusset Plate Stabilizer," shown in Figure 6-2. In order to assess whether these stabilizers were safe to operate in general service, it was decided that, prior to releasing the cars equipped with the stabilizing units for the extended period necessary to evaluate wheel wear and maintenance requirements, tests would be conducted under controlled conditions.

Extensive tests were made on the two stabilizers during February and March of 1972 while in place under the "A" end of two of their "bathtub" coal cars. It was noted that neither of the stabilizer designs made the truck frame completely rigid, as would be the case with a one-piece frame truck; however, the "Gusset Plate" design proved to be more effective in improving truck stiffness. Following a test sequence, which consisted of static testing and a series of instrumented road tests, the trucks equipped with the stabilizers were permitted to enter unrestricted service.

6.2 FEASIBILITY

In April and May of 1974, Canadian Pacific undertook a series of tests to determine the effectiveness of the Swiss hydraulic interbogie coupling device, a schematic diagram of which is shown in Figure 6-3.

Two fully-laden, 100-ton-capacity coal cars, equipped with hydraulic interbogie coupling devices and side frame stabilizers, were tested at the Canadian Pacific yard in Montreal on a 5-degree curve to determine the effectiveness of the interconnector in reducing lateral force levels and angle of attack. The two cars were tested with both the interbogie coupling and stabilizers working, with the interbogie coupling working alone, with the side frame stabilizers working alone, and with both devices inactive.

Lateral force measurements were made using Canadian National Research Department's instrumented base plates. Two base plates were installed on the outer rail of the test curve and one on the inner rail as shown in Figure 6-4. The base plates are designed for measuring both lateral and vertical tie-plate forces, but only lateral forces were analyzed in this test series.

Results of these tests were contradictory to what was expected, as lateral forces were higher with the stabilizer and interbogie coupling activated than without. Test data indicated that the device was apparently ineffective in reducing lateral curving loads as measured by the base plates. It was also noted that with profiled worn wheel sets on one car, there was a reduction of lateral curving forces as compared to tests on the same car with new AAR contoured wheels. The test consisted of 20 runs encompassing a speed range of 5 to 15 mph.

It was decided, in view of the inconclusive performance of the device in reducing lateral force levels during curve negotiations, that further testing should be undertaken. A road test was conducted to determine if the hydraulic system was functioning as designed, and also to determine the force levels in the mechanical linkages joining the side frames of each truck.

6.3 SERVICE EXPERIENCE

Other than in the test runs referred to in Paragraph 6.2, and transfer of the cars from Calgary to Montreal for evaluation, there has been no service experience.

6.4 AVAILABILITY

There is nothing about the device that would not be available or could not be produced commercially. Should it prove sufficiently successful, there should be no problem with availability.

6.5 COST FACTORS

As the hydraulic interbogie coupling device has only been produced as an experimental unit for two test cars, no figures are available on production costs. Limited operating experience with the interbogie equipment indicates that maintenance requirements would be appreciable.

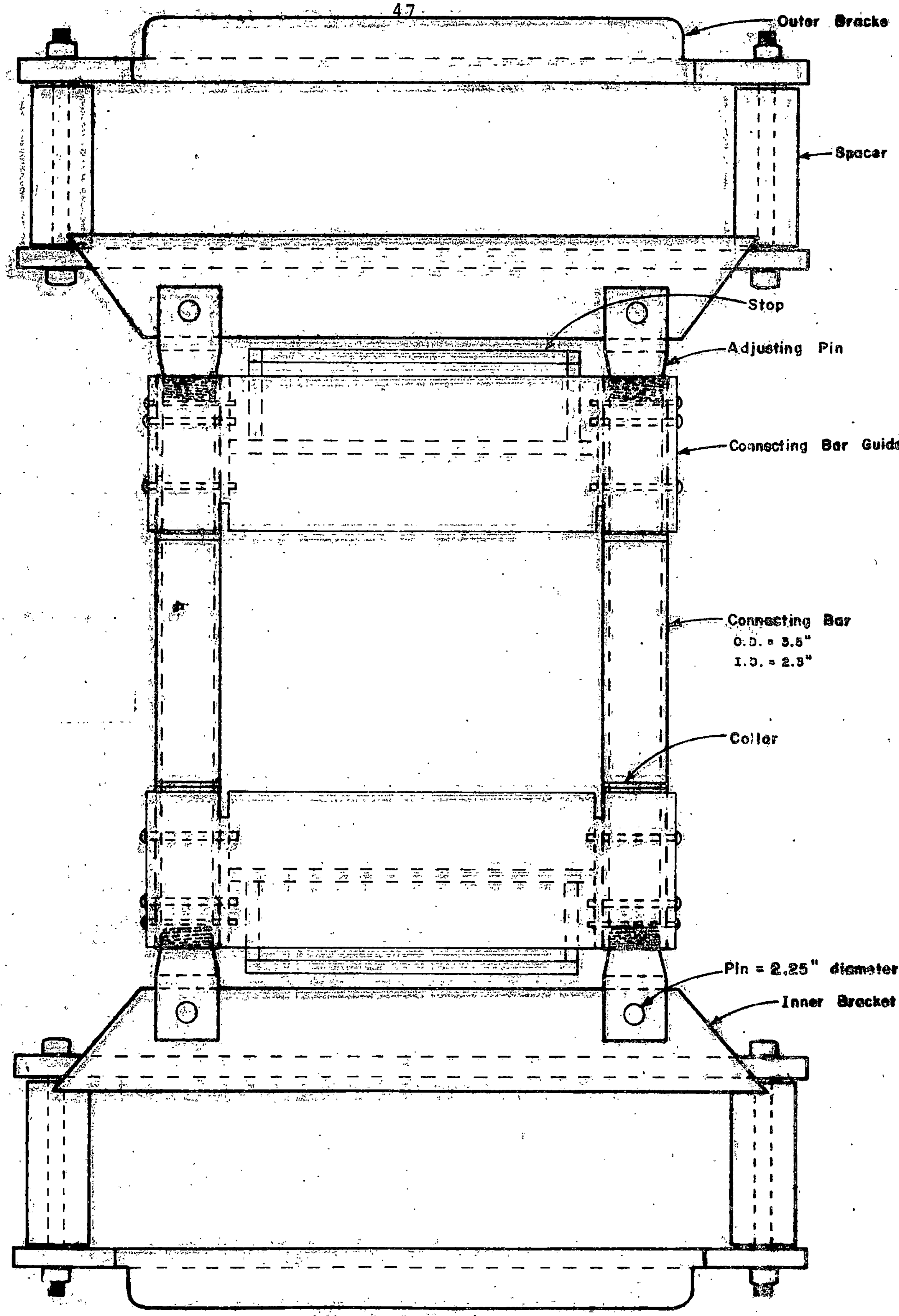


FIGURE 6-1

SADDLE PLATE STABILIZER

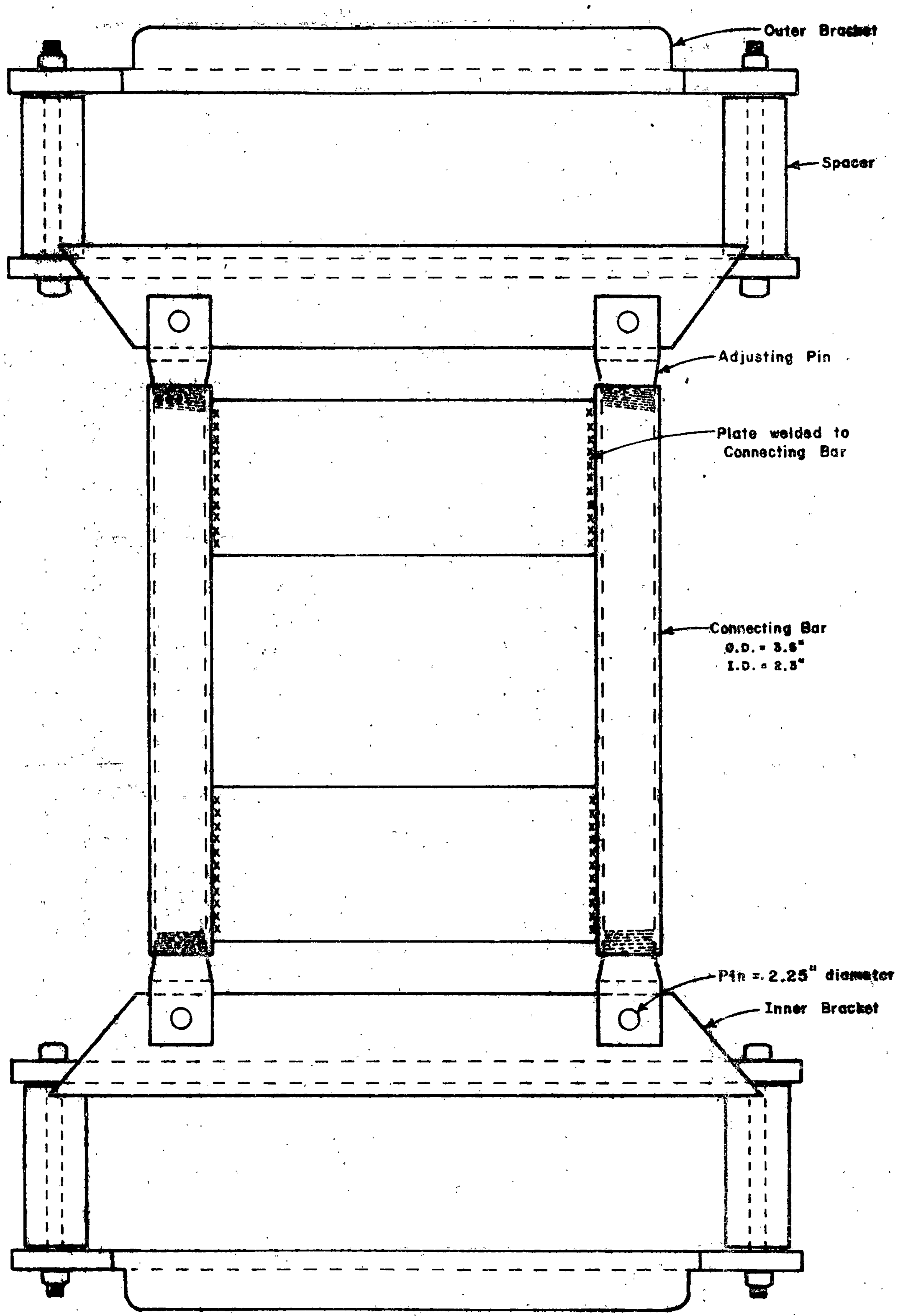


FIGURE 6-2
GUSSET PLATE STABILIZER

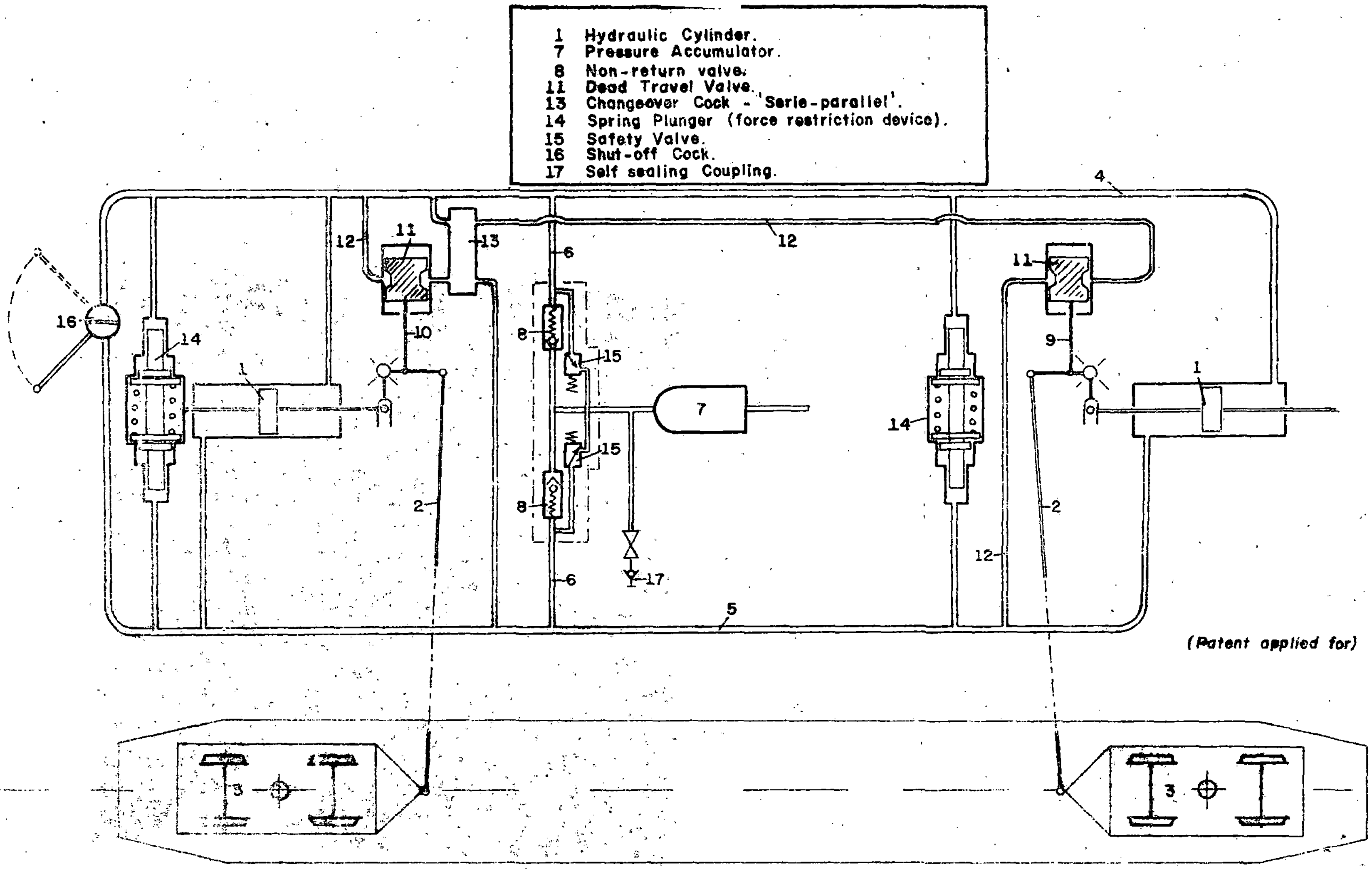
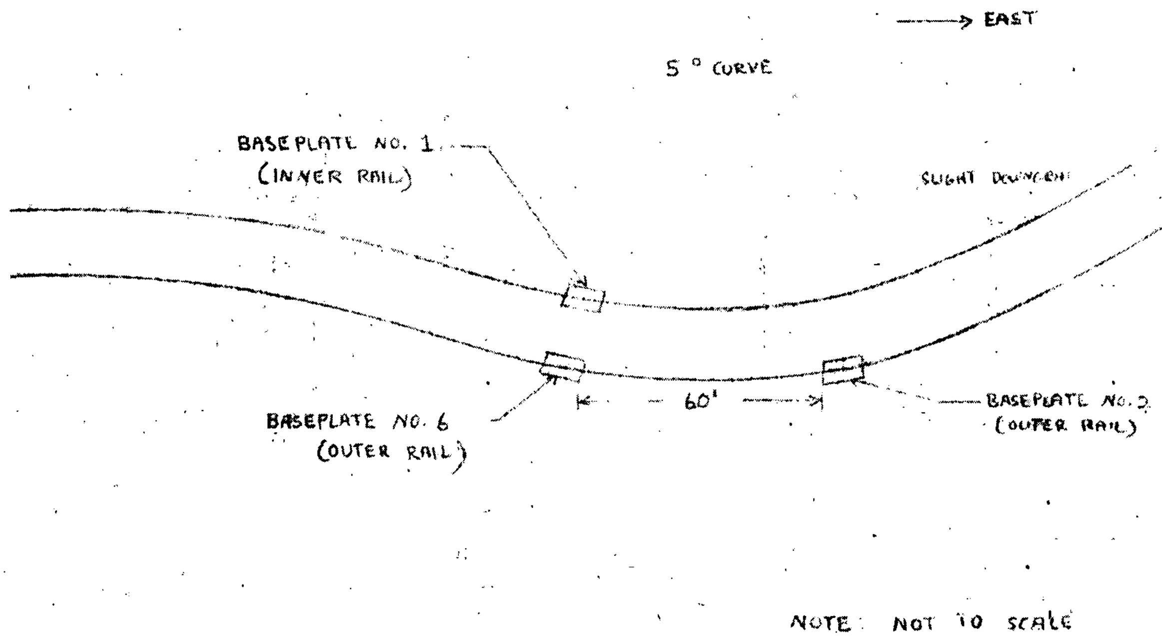


FIGURE 6-3

DIAGRAM - INTERBOGIE CONNECTION

GENERAL TRACK LAYOUT AT TEST SITE



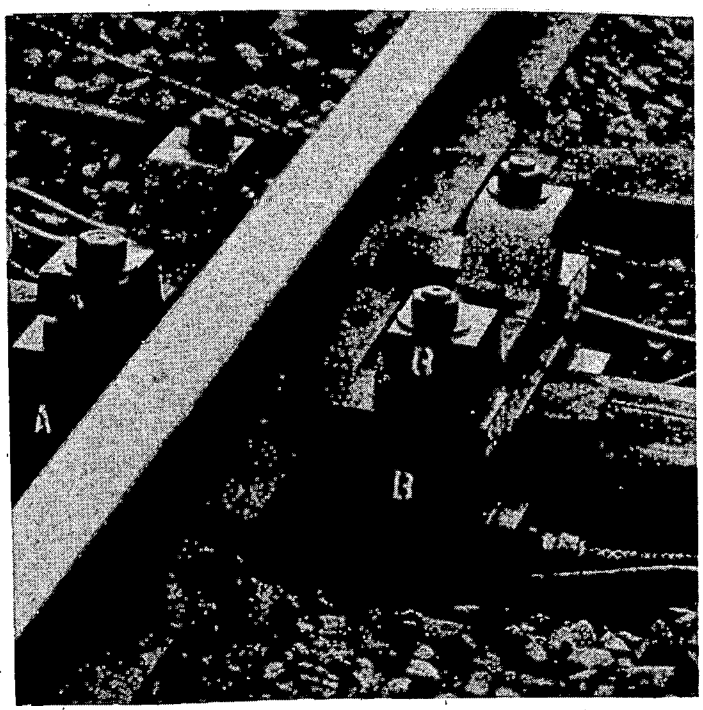


FIGURE 6-4

INSTRUMENTED BASE PLATE

Section 7

ACF FABRICATED TRUCK

7.1 TECHNICAL

The truck under development by Amcar Division of ACF Industries is of fabricated construction to be compatible with car builders' capabilities for manufacture, as well as an attempt to reduce weight and cost. It is made up of two side frames and a bolster with a secondary spring group in a somewhat conventional arrangement, but, in addition, has a tie between the side frames and is equipped with hydraulic snubbers. The truck arrangement is shown in Figures 7-1 and 7-2.

There is a flat rectangular plate in a horizontal position that ties the two side frames together designed to hold the truck frame rigid while providing additional equalization by allowing the side frames to rotate relative to each other. It is anticipated that holding the truck rigidly in tram will materially reduce unstable hunting, thereby reducing wear within the truck and car as well as to the track.

The pads directly over the side frames shown in Figure 6-1 carry all the vertical load of the car, giving a wide base which assists in better roll control. The sliding surfaces between the car and the truck are of specially developed materials designed to give a low and essentially constant coefficient of friction. The truck is pivoted on a conventional body center plate, mating with the truck center plate, which does not transmit vertical loads.

The springs are conventional AAR springs arranged to provide a two-step spring rate. When the car is unloaded or lightly loaded, more than normal spring travel is permitted which allows the four-point suspension to accommodate twisted track.

The journal bearings are mounted in half-rubber journal sleeves which provide an elastomer primary suspension that filters high frequency input which means that shock loads are materially reduced to both side frame and track.

The snubbers shown in Figure 7-1 are hydraulic shock absorbers selected because they are high-production units of reasonable cost.

7.2 FEASIBILITY

Two car sets of prototype trucks have been built and an initial test program is being run by ACF which they expect to complete by mid-1975. To date, the tests show a successful performance with noticeable improvement in rock and roll with reduced wheel lift. Tests were performed under center-flow covered hopper cars.

Original tests showed more friction at the sliding surface between the truck bearing surface and the car than desired; however, new materials developed for this interface have minimized the problem.

The approach appears to be feasible both from manufacturing and performance standpoints. Design features requiring field testing include the bearing surface between truck and carbody, the hydraulic snubbers, the elastomer pads at the journals, as well as the welded construction.

7.3 SERVICE EXPERIENCE

Other than the tests referred to in Paragraph 7.2, there has been no service experience with the truck.

7.4 AVAILABILITY

The design is a proprietary development by Amcar Division of ACF Industries in St. Charles, Mo., and would be available from them.

7.5 COST FACTORS

It is the aim of ACF in this development that the truck be competitive with standard trucks in first cost with substantially less maintenance costs. The hydraulic snubbers are the same units used on some locomotives and transit cars and experience indicates good reliability. The fact that they are high-production units should result in low replacement cost. Most parts which might require replacement are standard. Improved tracking characteristics would result in reduced truck and wheel wear as well as track wear.

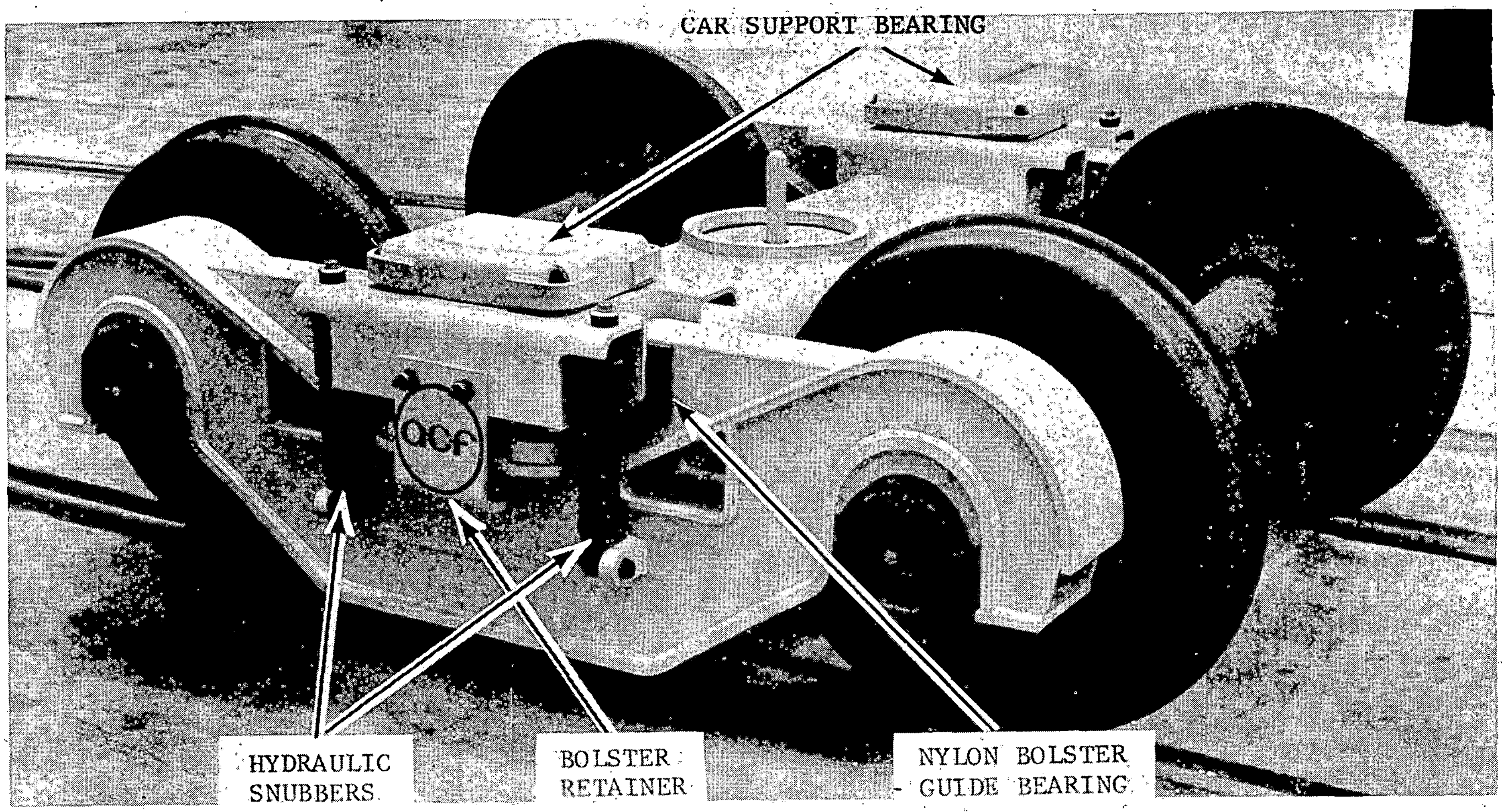


FIGURE 7-1

A.C.F. FABRICATED TRUCK

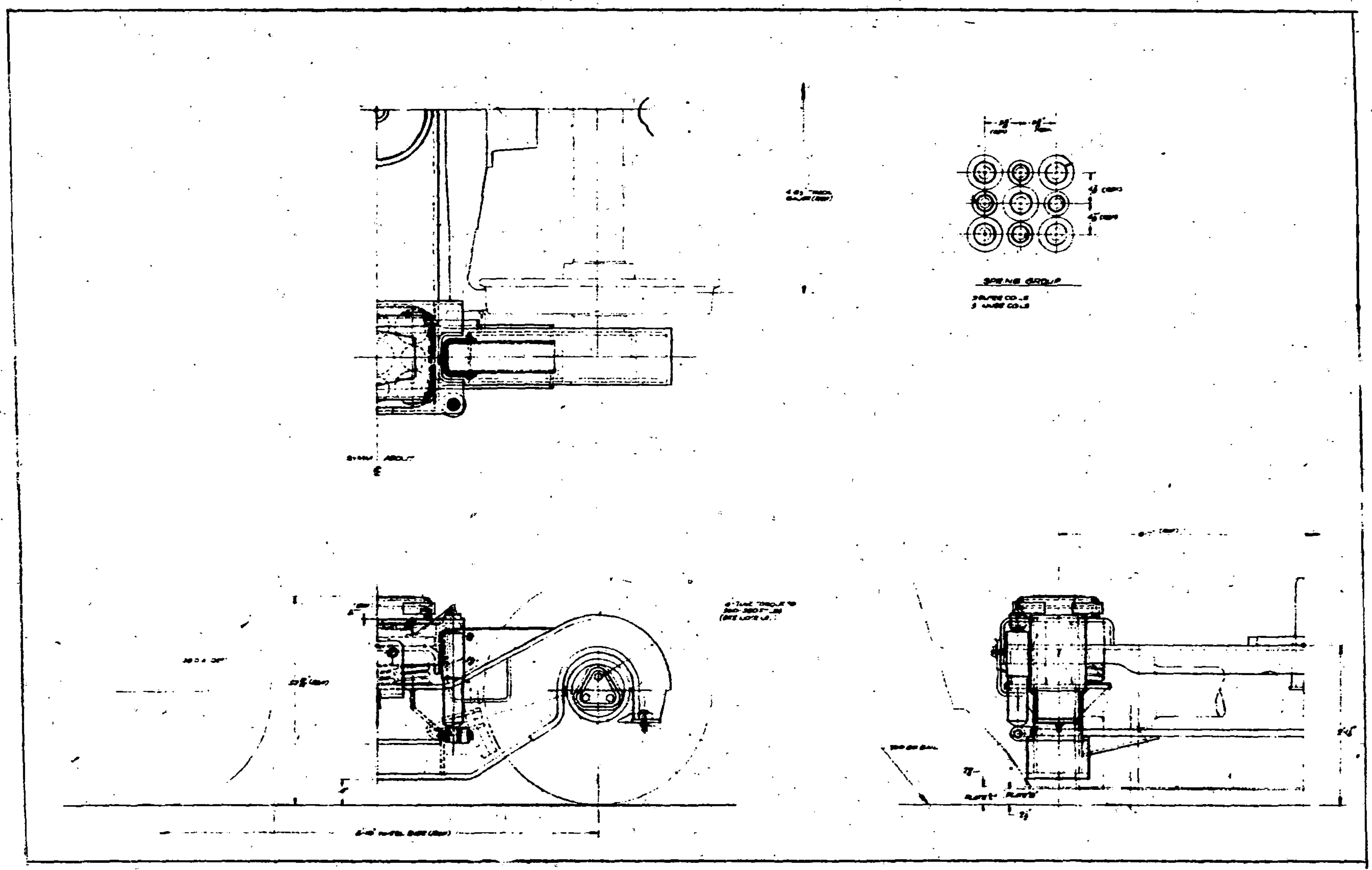


FIGURE 7-2

TRUCK ARRANGEMENT - ACF

Section 8

NATIONAL SWING MOTION TRUCK

8.1 TECHNICAL

The "Swing Motion" truck developed by National Castings Division of Midland-Ross Corporation is made up of two cast-steel side frames and a cast-steel truck bolster arranged in a conventional manner. It has standard wheels, axles, roller bearings, roller bearing adapters, truck center plates, and side bearings. Arrangement of the Swing Motion truck is shown in Figures 8-1 and 8-2.

The truck is held in tram and prevented from "parallelogramming" by incorporating a transom connecting the two side frames through special rocker seats and their mating longitudinally spaced rocker bearings. By virtue of this design, the vertical load carried by the truck, with the frictional resistance against rotation, augmented by shape of the rocker bearings, resists unsquaring to a considerable degree, but does not completely "rigidize" the truck to the same extent as would a one-piece frame. Arrangement of the rocker seat is shown in Figure 8-3.

The transom connecting the two side frames serves a dual purpose, the major one being to provide for controlled lateral motion. This is accomplished by the transom connecting the two side frames (and supporting the load springs) having a rocker connection with the side frames through the aforementioned rocker bearings. A rocker connection is also provided between the roller bearing adapters and the side frames by the use of special pedestal rocker seats. This arrangement permits the side frames to swing laterally in unison as pendulums or "swing hangers." Swinging of the side frames is stopped by contact between the side frame tension member and underside of the rocker seat. The clearance between these stops permits a 3° side frame swing to each side from the center. The resistance to lateral motion is dependent on the weight of the car (with its lading) and is "controlled" by the natural tendency of this heavy pendulum to return to bottom dead center. An additional 5/8-inch lateral motion to each side (resulting in a total of 1-1/4 inches) is obtained by lateral deflection of the load springs. This principle of obtaining controlled lateral motion is illustrated in Figure 8-4.

The feature for control of "rock and roll" is illustrated in Figure 8-5. It is accomplished by eliminating conventional gibs on the truck bolster and providing lateral stops between the bolster and the transom at the height of the side frame spring seat. As indicated in the illustration, reducing the overturning moment of the truck produces a natural control for minimizing car roll without special anti-roll devices.

The truck is provided with "two-stage," long-travel, load springs. The dual rate is accomplished by utilizing shorter inner coil springs, which are held in place by special hold-down cups and springs on the top of the inner coils. This principle is illustrated in Figure 8-6.

The manufacturer makes the following claims for this development:

- Eliminates unstable truck hunting
- Provides controlled lateral motion to minimize lateral shocks
- Minimizes "rock and roll" with consequent possibility of derailment
- Makes significant reduction in lading damage
- Makes significant reduction in center plate wear and allows elimination of hardened wear liners

- Makes significant reduction in wheel and rail wear
- Provides a "soft" ride for light loads and adequate spring capacity for heavy loads

8.2 FEASIBILITY

A number of railroads have run tests on the National Swing Motion truck, and considerable data are available on its performance.

In 1968, high-speed road tests were run on the Santa Fe to obtain data on performance of the Swing Motion truck as compared to conventional trucks. Test results show that the truck was stable with no evidence of unstable lateral hunting up to speeds of 93 mph which was the maximum speed obtained. Conventional trucks in the test were unstable at speeds over 55 mph. The lateral ride quality of the car equipped with Swing Motion trucks was superior to the lateral ride of a car equipped with conventional freight car trucks. The vertical ride of a light car equipped with Swing Motion trucks having the two-stage load springs was considerably improved over conventional trucks; however, with fully loaded cars, the vertical ride was about the same.

In 1968 and 1969, tests were made by the AAR (on L&N track) of the roll characteristics of the Swing Motion truck. These tests indicated the truck to be satisfactory under roll conditions and considerably superior to conventional trucks. These tests are covered by AAR Test Report LT199.

A joint road test was run in January 1971 by Pacific Fruit Express Co., Southern Pacific Transportation Co., and Union Pacific Railroad. This test was made on refrigerator cars and test data indicated a considerably improved ride for the National truck over conventional trucks. Three car sets of National Swing Motion trucks were placed in service under PFE refrigerator cars in August of 1970 for a continuing service test.

In December of 1974 and January of 1975, two of the test trucks under the PFE cars were routed into National Castings Division's Technical Center in Cleveland, Ohio where they were completely disassembled and all parts inspected. Results of this inspection are detailed in the National Technical Center report of July 8, 1975. The cars had accumulated an average of 215,000 miles at the time of inspection and were in good condition with minimal wear. Projection of the wear rate indicates that mileage before repair or replacement of parts will be required should be between 450,000 and 500,000 miles for items such as bolster ends, center plates, side frame columns, etc., and between 600,000 and 700,000 miles for wheels.

In May of 1971, a joint road test was run by the Southern Pacific and Union Pacific between Las Vegas, Nevada and Yermo, California to determine the cause of a number of single-axle derailments and to establish the reason for unstable ride characteristics of empty bulkhead flat cars.

The empty flat cars tested with conventional trucks showed unstable hunting at speeds of 50 mph. At speeds above 60 mph, the unstable hunting produced accelerations of sufficient magnitude to explain the single-axle derailments. The National Swing Motion truck was tested and no unstable lateral truck hunting was observed up to speeds of 77 mph.

Road and service tests that were reviewed seem to confirm the manufacturer's claims and the truck design is considered feasible and operational.

8.3 SERVICE EXPERIENCE

There are 460 car sets of 70-ton-capacity National Swing Motion trucks in service under box, hopper, auto rack, flat, and refrigerator cars. The test trucks applied under the PFE refrigerator cars in 1970 have now accumulated over 200,000 miles with no service problems experienced to date.

There are 200 car sets of 100-ton-capacity trucks in service applied to Union Pacific high roof box cars and bulkhead flat cars; however, these applications were recent and no service experience is yet available.

8.4 AVAILABILITY

The Swing Motion truck is a proprietary item manufactured by National Castings Division of Midland-Ross Corporation in Sharon, Pennsylvania, and is available from them.

8.5 COST FACTORS

First cost of the Swing Motion truck is approximately $2,500 per car set higher for the 70-ton version and $2,600 per car set higher for the 100-ton version than that of conventional trucks.

Wear patterns observed to date indicate that maintenance costs will be considerably less. Wheel wear is reduced appreciably and other wearing parts of the trucks, such as center plates, show much less wear than conventional trucks. Manufacturer's estimates indicate a saving of $9,000 in one million miles.

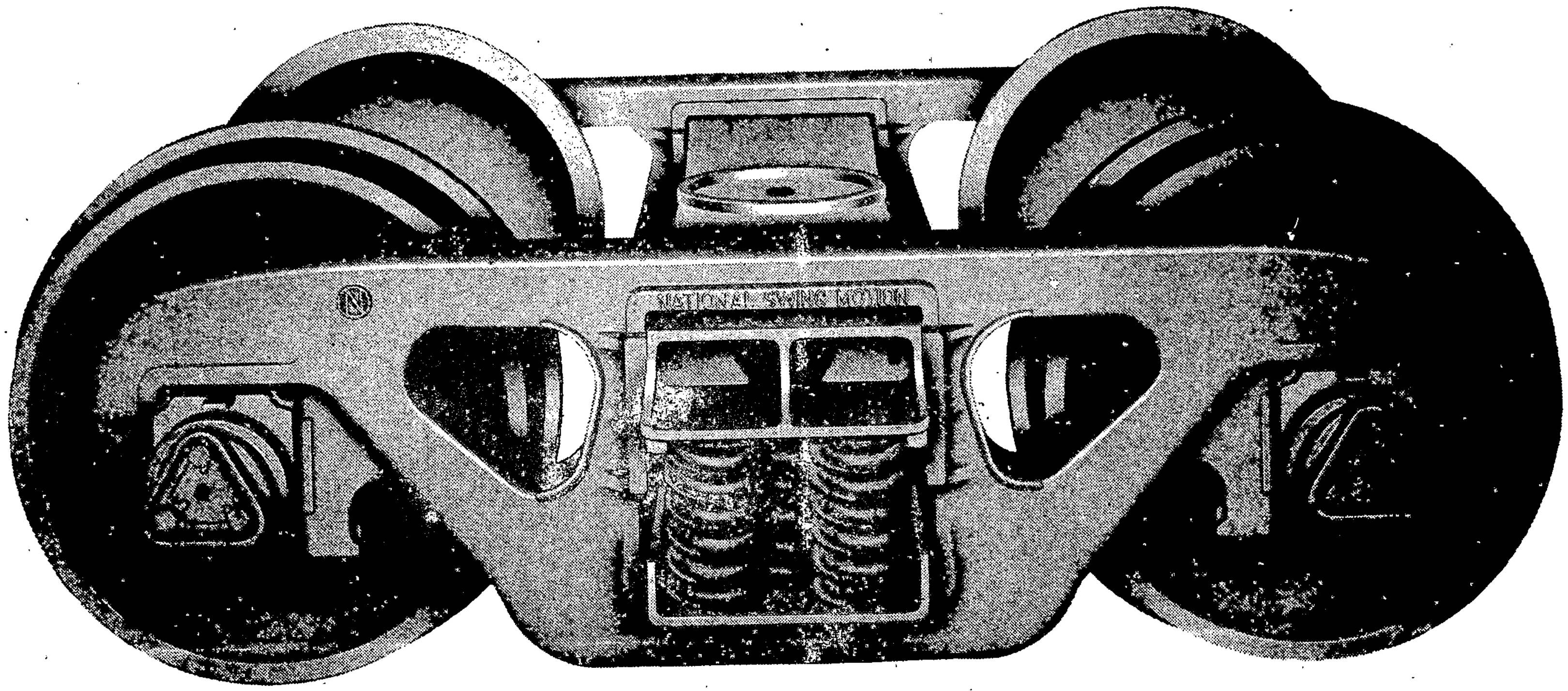
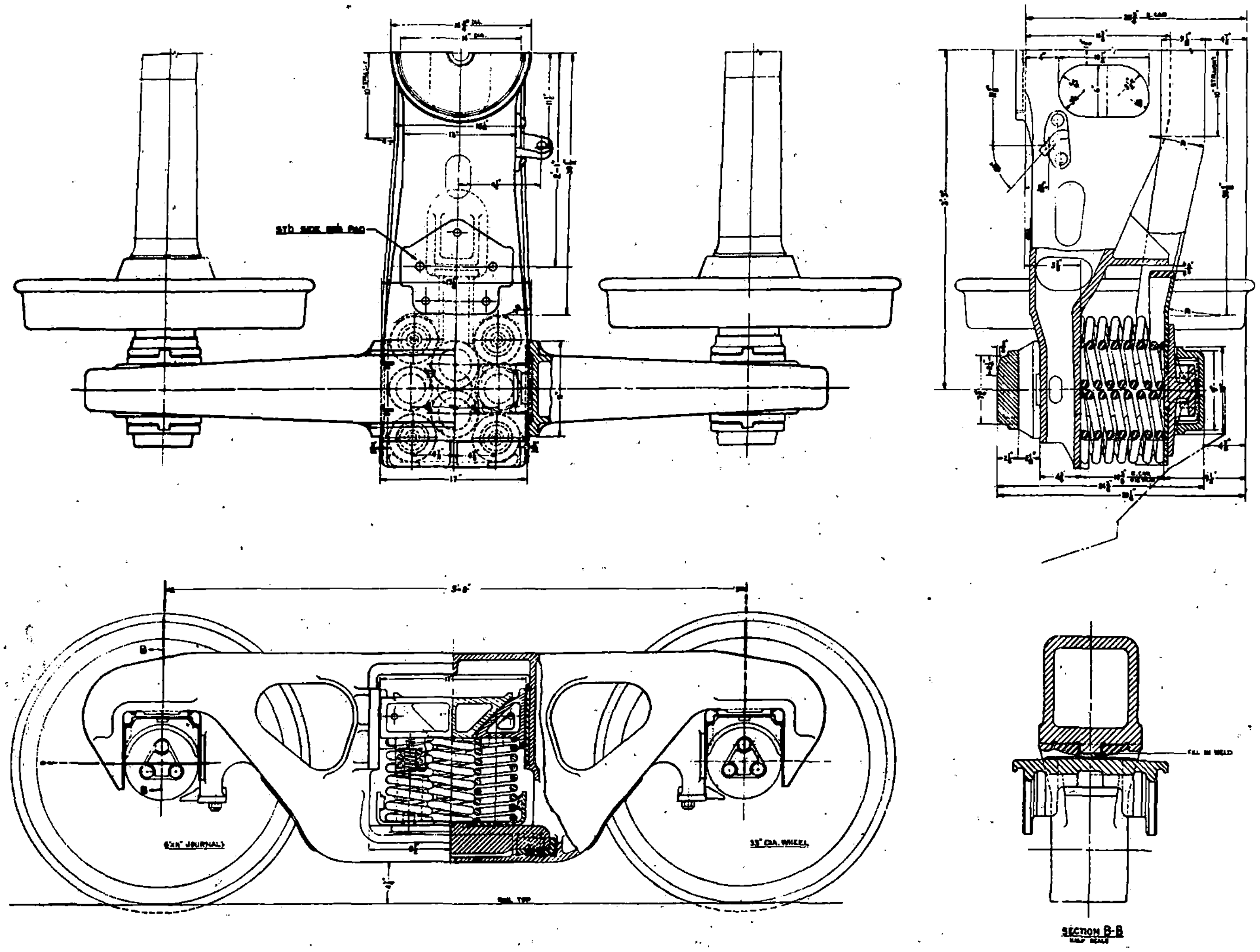


FIGURE 8-1

NATIONAL SWING MOTION TRUCK



NOTE:

LOAD SPRING GROUP - 4½" TRAVEL

6-OUTER COIL SPRINGS	- 48451	PER SPR'G GROUP
4-INNER COIL SPRINGS	- 48460	PER SPR'G GROUP
2-WEDGE SPRINGS	- 48448	PER SPR'G GROUP
4-HOLD DOWN SPRINGS	- 48450	PER SPR'G GROUP
4-FRICTION WEDGES	- 48446	PER TRUCK
2-SIDE FRAME	- 48440	PER TRUCK
1-BOLSTER	- 48445	PER TRUCK
1-TRANSOM	- 48447	PER TRUCK
4-6x11 STANDARD ADAPTERS		PER TRUCK
2-ROCKER SEATS	- 48444	PER TRUCK
4-ROCKER SEAT BEARINGS	- 48443	PER TRUCK
4-PEDESTAL ROCKER SEATS	- 48441	PER TRUCK
4-FRICTION WEAR PLATES	- 49442	PER TRUCK
1-D.L.F. BRACKET	- 37847	PER TRUCK
1-VERTICAL RING WEAR LINER	- 43282	PER TRUCK
4-SPRING CUPS	- 48449	PER SPR'G. GROUP

6x11 SWING MOTION TRUCK
GENERAL ARRANGEMENT
VAR. CONTROL & LONG TRAVEL SPRINGS

FIGURE 8-2

ARRANGEMENT - NATIONAL SWING MOTION

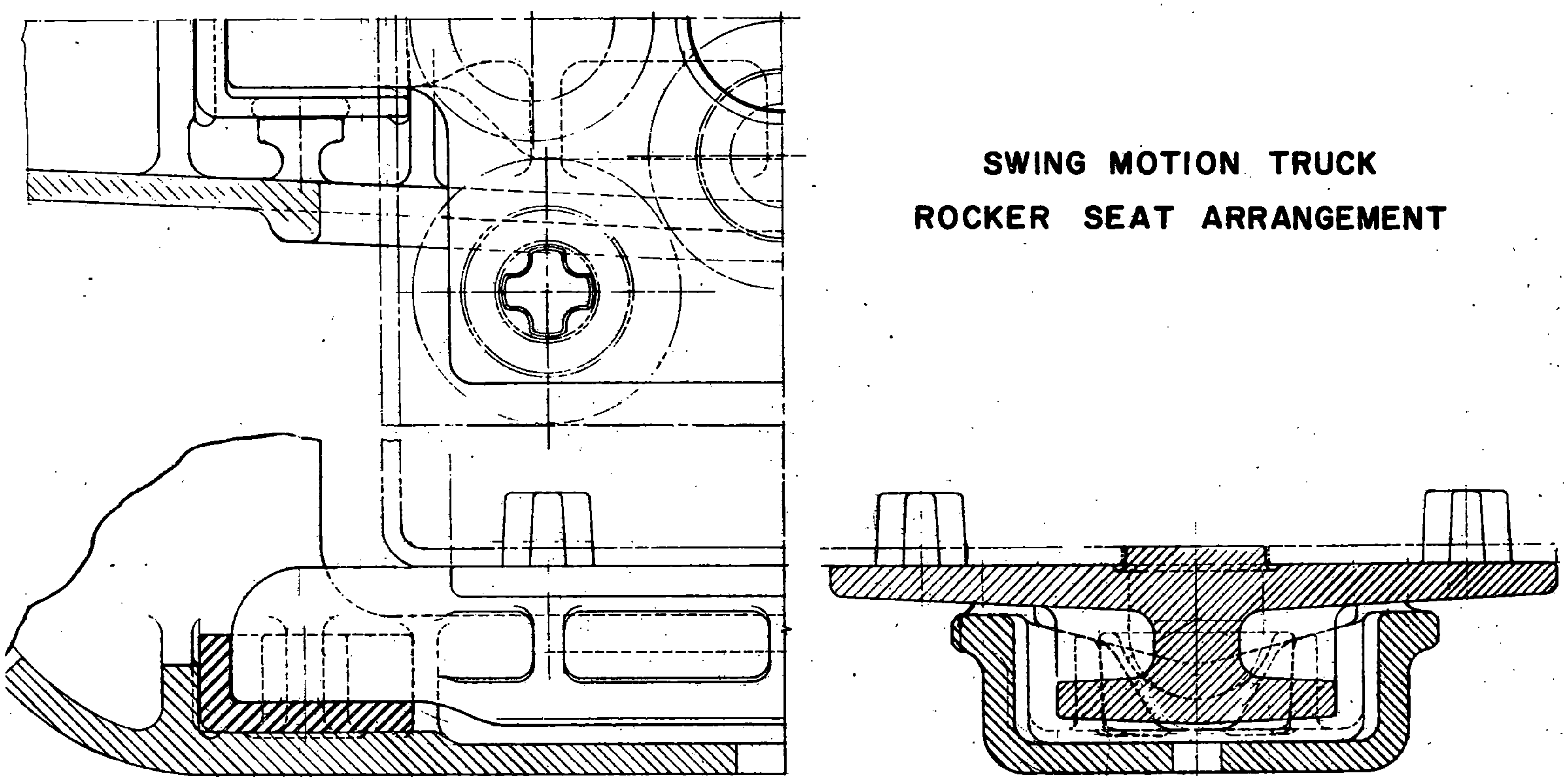
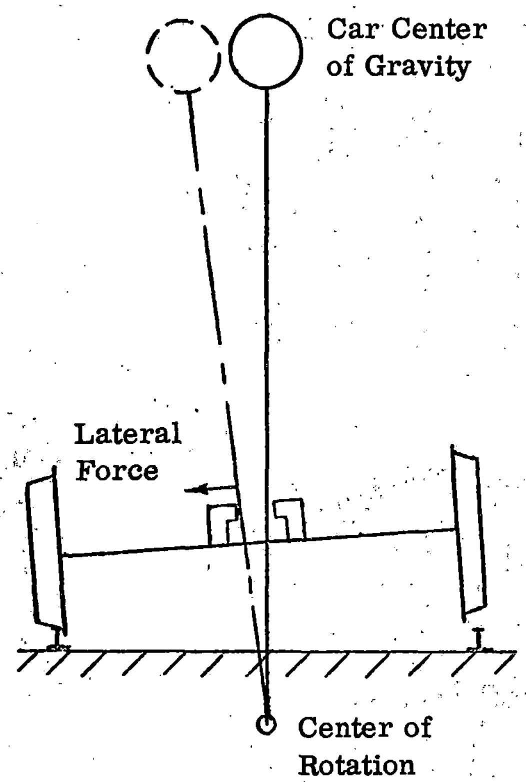


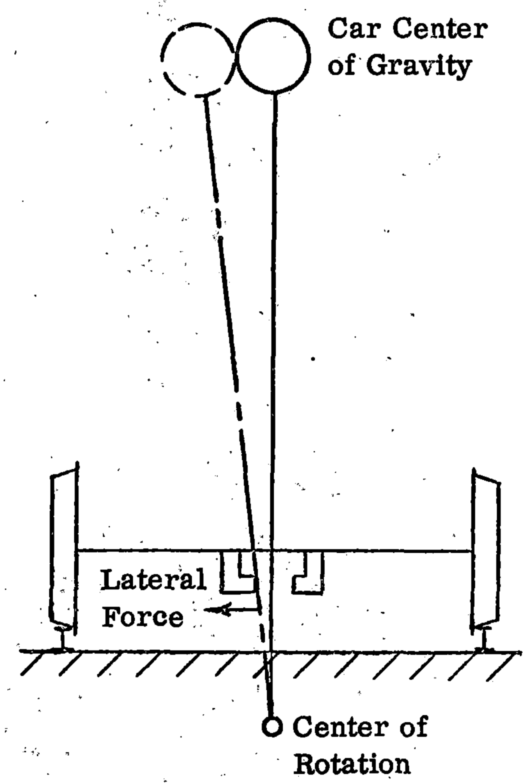
FIGURE 8-3

ROCKER SEAT

Schematic Diagram of Rolling Cars



Conventional Truck



Swing Motion Truck

When a car rocks, lateral forces are transmitted through the bolster gibs to the side frame columns. The distance from the line of lateral force to the center of rotation times the lateral force equals the overturning moment of the truck. This overturning moment can cause wheel lifting and derailment.

On the Swing Motion truck the lateral stops are lowered. The lateral forces are transmitted from the bolster bracket to the transom and to the side frame through the spring seat. This reduces the distance to the center of rotation and thus reduces the overturning moment. Wheel lifting and derailment are minimized.

FIGURE 8-5

ROCK CONTROL

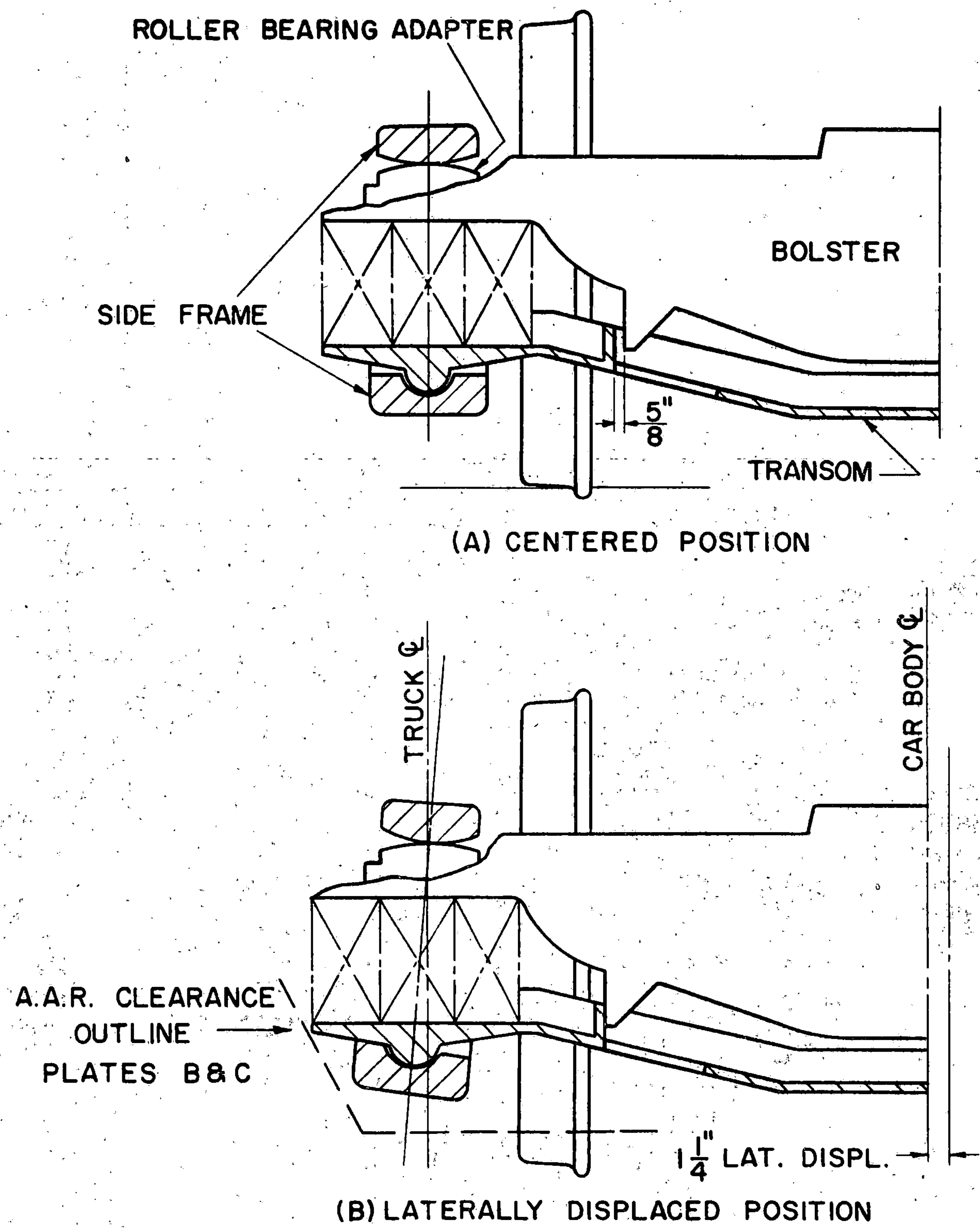


FIGURE 8-4

TRUCK LATERAL

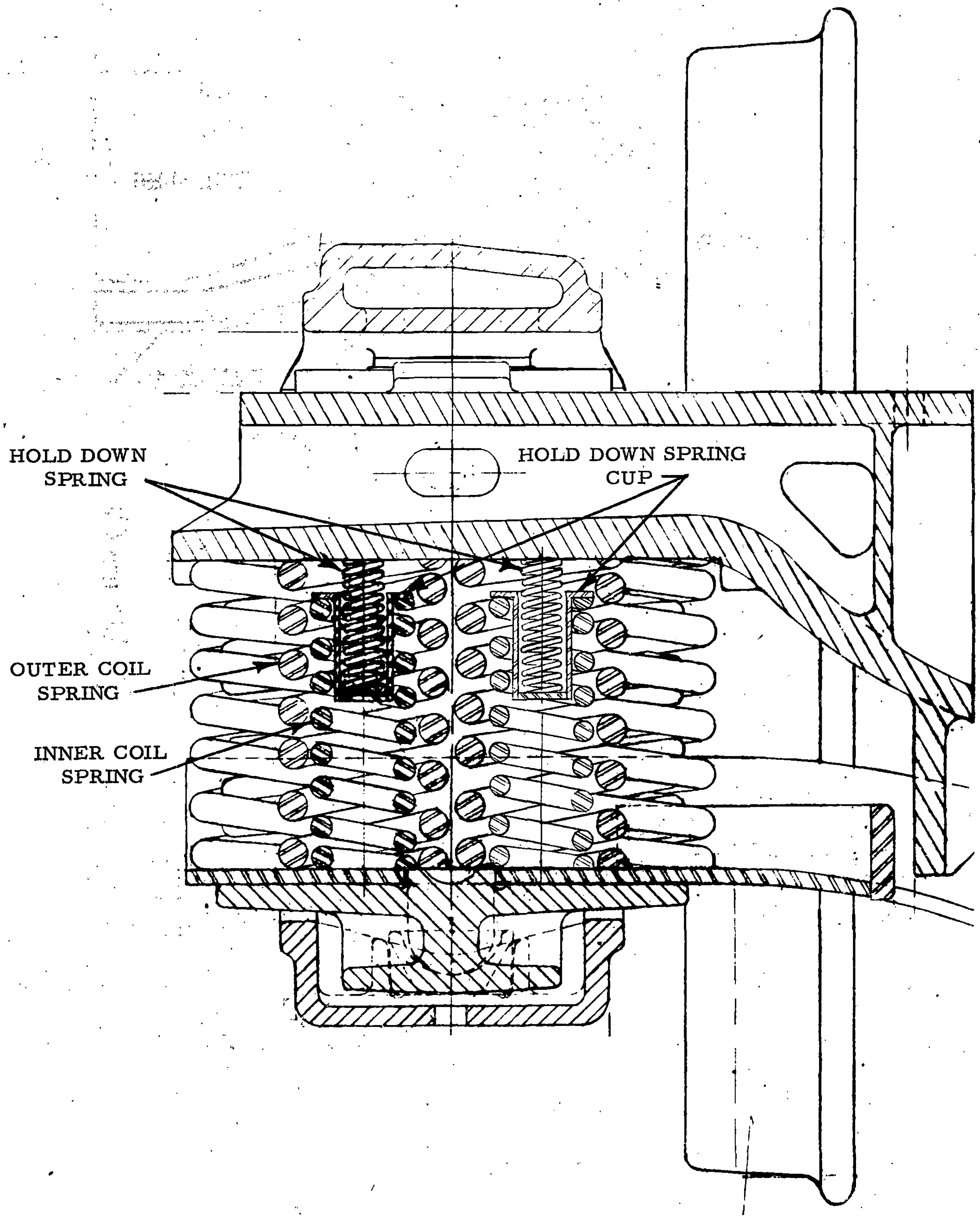


FIGURE 8-6

DUAL RATE SPRINGS

Section 9

UNION INTERNATIONALE DES CHEMINS DE FER Y-25 TRUCKS

9.1 TECHNICAL

The Union Internationale des Chemins de Fer (International Union of Railways) with headquarters in Paris has developed a "family" of freight car trucks (bogies) designated as the Y-25 series. The major manufacturer of these trucks is the Societe Franco-Belge de Materiel de Chemins de Fer who supply European railroads with five different types of the Y-25 truck. They also supply various types of special trucks and other railroad freight equipment.

The Y-25C type truck has been in service since 1965 and is designated for "S" speed which is 100 km/hr. It is the most widely used Y-25 truck in service; however, the Y-25Cs, which is a later version, is the only standard truck that has been fully approved by U.I.C. for "S" service. The Y-25C is shown in Figure 9-1 and the Y-25Cs in Figure 9-2.

The truck is a fabricated type with bolster, side frames, and end ties, welded into a one-piece rigid frame. It has a primary spring system with friction snubbers at each axle box which are load sensitive. The truck has conventional brake beams and levers and is rigged for clasp brakes. It is fitted with rigid friction side bearings located on the bolster immediately inboard of the side frames.

The truck has roller bearing axle boxes (217 x 130 mm journals) mounted at the side frame pedestal in a conventional manner for a primary spring arrangement. It is held rigidly in tram by nature of the rigid truck frame. There is no provision for controlled lateral motion.

9.2 FEASIBILITY

The Y-25 series trucks have been in service in Europe since 1965 and are used extensively on European railroads. Tests run by U.I.C. indicate that the truck is stable and operates safely up to 120 km/hr. Results indicate a significant improvement in ride quality, particularly in the lateral plane,over the conventional three-piece design freight car truck.

The design is feasible and performance should be comparable to any similar rigid frame truck with a primary spring arrangement.

9.3 SERVICE EXPERIENCE

Over 60,000 car sets of the Y-25 design have been placed in service since 1965, and the manufacturer claims an entirely satisfactory performance.

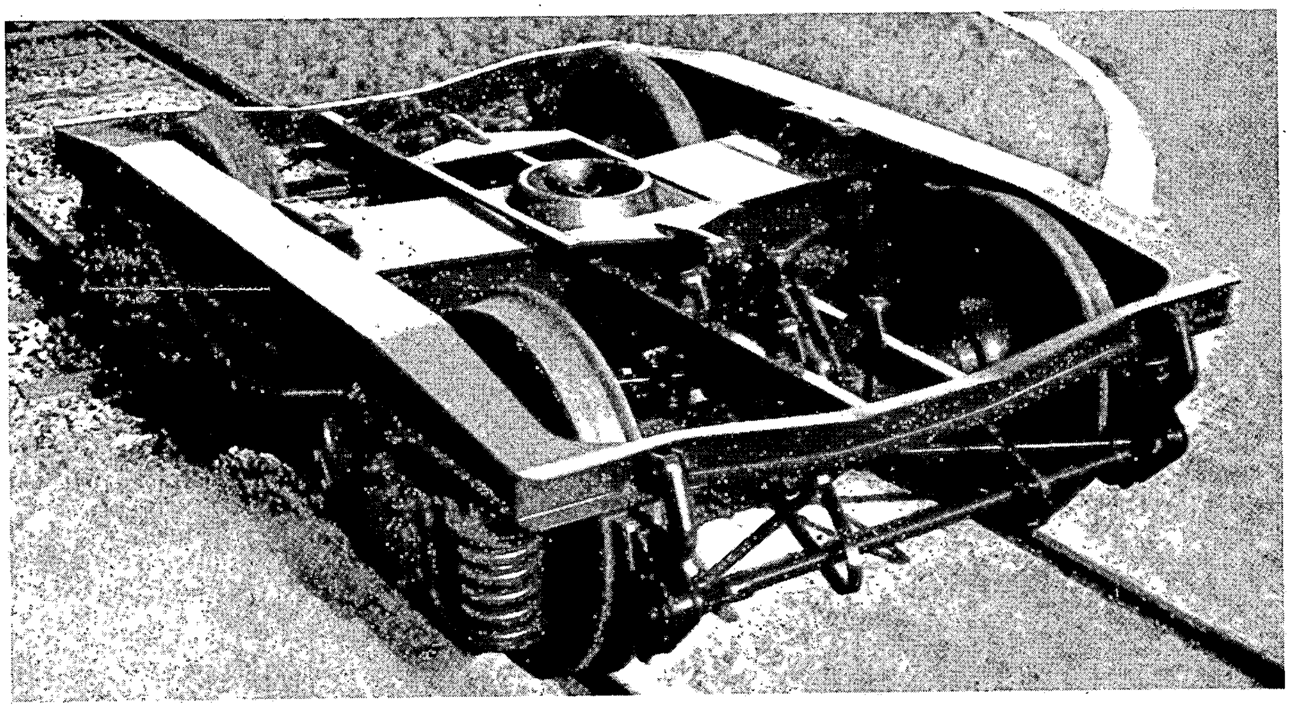
9.4 AVAILABILITY

An Americanized version of the Y-25 truck would be available from European manufacturers; however, there is nothing about the design that would preclude its being mass produced in the United States should this become desirable.

9.5 COST FACTORS

Precise cost figures, as compared to conventional design trucks in the United States, are not available, but while it is considered a "premium high-speed truck," there is nothing about the design that would indicate an excessively high first cost.

The manufacturer's statement on maintenance cost is "our trucks are only checked every five years," and that such costs are "appreciably reduced." Unstable hunting should be reduced by the rigid frame design with a corresponding reduction in wheel wear as well as wear on other truck parts.



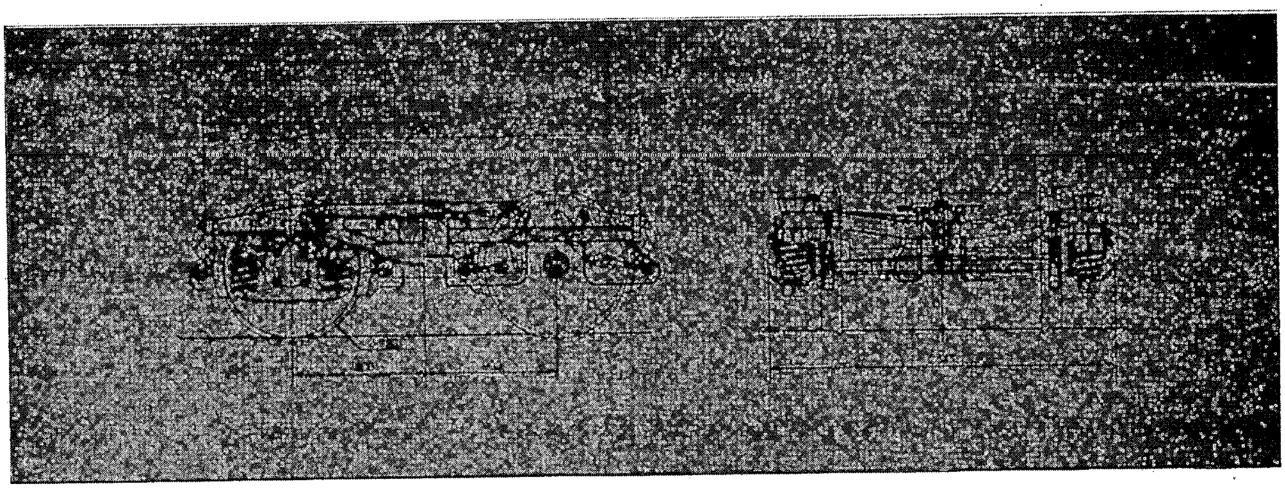


FIGURE 9-1

Y-25 C TRUCK

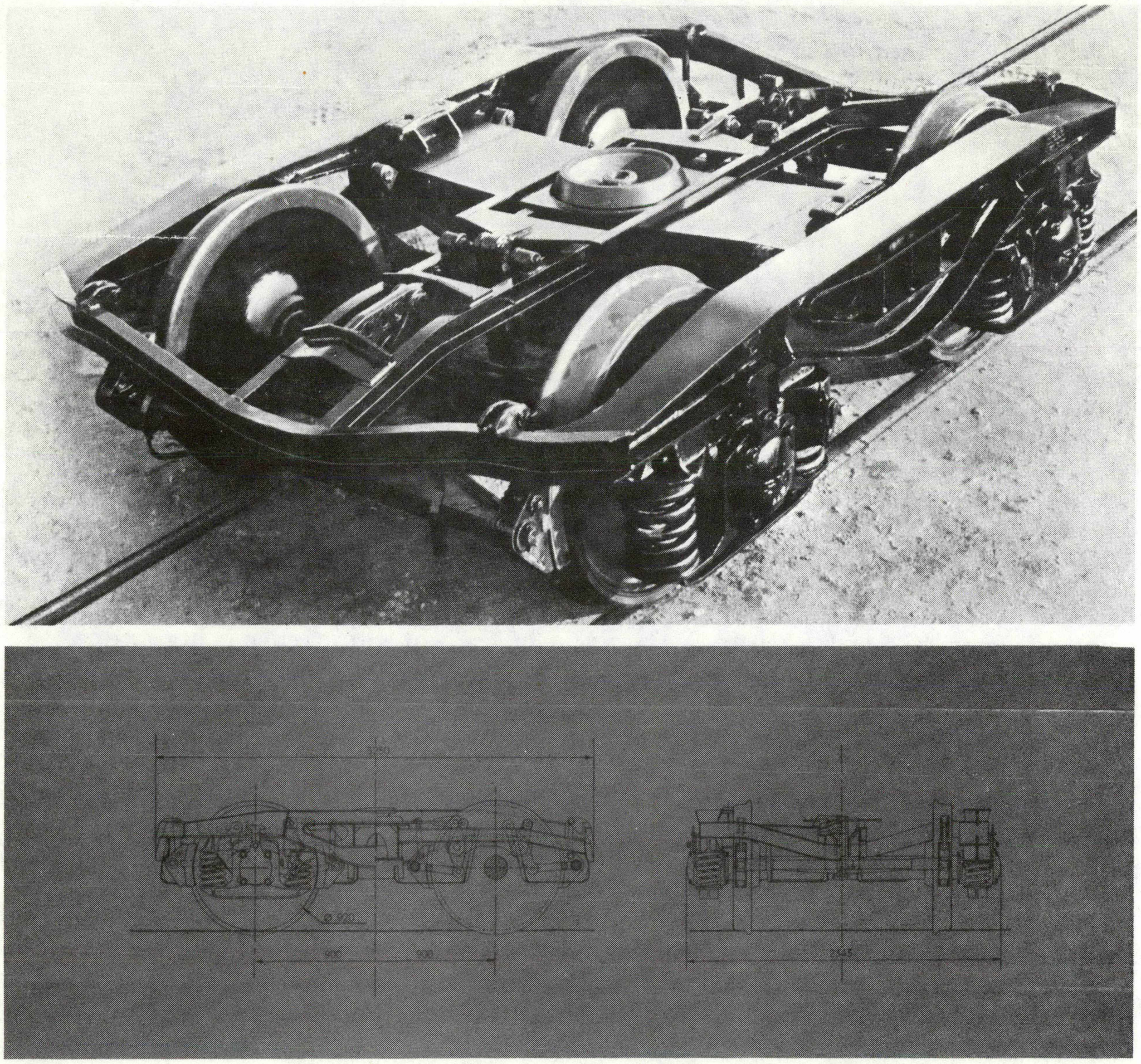


FIGURE 9-2

Y-25 Cs Truck

Modified F-25

Section 10

GLOUCESTER GPS-25 TRUCK

10.1 TECHNICAL

In the late 1960's, the British Railways Board advised all truck manufacturers in England that because of excessive track damage and wear on conventional three-piece trucks, consideration must be given to the design of a primary suspension truck. British Railways subsequently made it mandatory (1971) that all types of freight vehicles having gross laden weights of 90 and 100 (UK) tons be equipped with rigid frame, primary suspension type trucks.

The major manufacturer of this design truck in England is Gloucester Railway Carriage and Wagon Co. They have designated their design as the "GPS-25" truck for "Gloucester Primary Suspension" with 25-ton axle load capacity. Truck arrangement for use on British Rails is shown in Figure 10-1.

The design consists of a one-piece, all welded "H" frame, with either a two or a three-stage primary suspension, load-sensitive friction snubbers, a "hemispherical" center plate, and resilient side bearings. It can be fitted with either conventional inside brake beams, clasp brake or disk brakes, as desired. Gloucester has investigated a cast-steel design; however, to date only a fabricated version has been manufactured. The truck frame is a box section, fabricated from steel plate. It consists of two side frames and a bolster built as a rigid "H" frame designed to withstand all loads without the use of end transoms. Designers worked closely with the British Welding Institute to ensure that correct welding design and techniques were used. A photograph of the truck for British Rail (utilizing clasp brakes) is shown in Figure 10-2.

Friction snubbers are arranged on the outboard side of the axle box and consist of an incline-plane pot/cap device which, in turn, forces a friction pad against the friction surface of a saddle casting. The device is load sensitive by reason of the incline-plane pot/cap being fitted as a support cap for the outboard springs. The snubber arrangement is shown in Figure 10-3. The axle box and spring arrangement is shown in Figure 10-4.

10.2 FEASIBILITY

In 1971, a ride test was conducted on the fabricated version by the Chief Engineer, Traction and Rolling Stock Department of the British Railways Board. This test is covered by their report No. T-189, dated August 1971.

The conclusions of this report indicated that the GPS-25 rigid frame truck has overcome the main disadvantages of the three-piece design by producing a satisfactory ride at high speeds in conjunction with a low rotational resistance and therefore renders the GPS design more suitable for high speed freight service. Although only tested at 70 mph, the trend of the ride index curves indicated that with suitably matched suspension characteristics the riding properties will be satisfactory for vehicles running at speeds up to

75 mph. The low rotational resistance obtained without detriment to lateral riding properties should insure low flange wear and improve safety from derailment on slow speed curves. It was further concluded that the test tank car, fitted with GPS-25 trucks, was acceptable in terms of riding properties, rotational resistance and torsional stiffness characteristics for operation on British Rail Lines at speeds up to 100 km/hr empty or loaded.

British Railways Research Department made a "Static and Service Stress Measurement and Fatigue Assessment" on the fabricated prototype in 1971. These tests are covered by their Research Department's report of February 1972.

The measured stresses confirmed the calculated design stresses in most places where the loading was relatively simple; however, design calculations did not predict the influence of the major structural discontinuity at the side frame-bolster connection. Critical weld details in this area were subjected to a "fatigue damage estimate procedure" which predicted inadequate service life. Modifications to improve the expected service life at these areas beyond 2 million miles were suggested and adopted. After modification, the design was considered to be adequate.

A 70-ton-capacity, Americanized version of the GPS-25 truck was tested extensively by Trailer Train in 1974. They examined the comparative ride qualities of several trucks as opposed to conventional three-piece freight car trucks. These tests were made on a 70-ton-capacity container car. Truck arrangement of this version is shown in Figure 10-5 and application to the Trailer Train car is shown in Figure 10-6.

Levels of lateral car body acceleration at each end, car body lateral translation, and car body yaw were all reduced with the GPS-25 truck. It was observed that wheel-set motion is quite different from trucks that provide for lateral movement. On the GPS-25 truck wheel sets were virtually motionless in the lateral direction in relation to the car body. This was attributed to the resilient side bearing's tendency to restrain motion of the truck frame in the lateral plane rather than to basic design. Results of these tests indicated that the GPS-25 truck was stable and gave an acceptable ride performance. Overall performance was considerably improved over conventional trucks.

The GPS-25 truck is similar in design to the UIC Y-25 truck used in France, so, considering the experience in Great Britain, Europe and the United States, the design appears to be entirely feasible.

10.3 SERVICE EXPERIENCE

There are about 150 car sets of GPS-25 trucks operating on British railroads under all types of freight cars. The first of these cars was placed in service in 1971 and to date no problems have developed.

10.4 AVAILABILITY

Gloucester Railway Carriage and Wagon Co. has a licensing arrangement with Buckeye Steel Castings of Columbus, Ohio, and an Americanized version of the truck may be available from them. The test trucks used by Trailer Train will probably be available for test in the TDOP program, if desired.

10.5 COST FACTORS

Little information is available on costs as compared to conventional design trucks in the United States, but while it is considered a premium truck there is nothing about the design that would indicate an excessively high first cost.

The British estimate that first cost of the GPS-25 truck is 27 percent higher than their conventional three-piece truck.

The rigid frame design and resilient side bearings should materially reduce unstable hunting, thereby reducing wheel wear and lowering general truck maintenance costs.

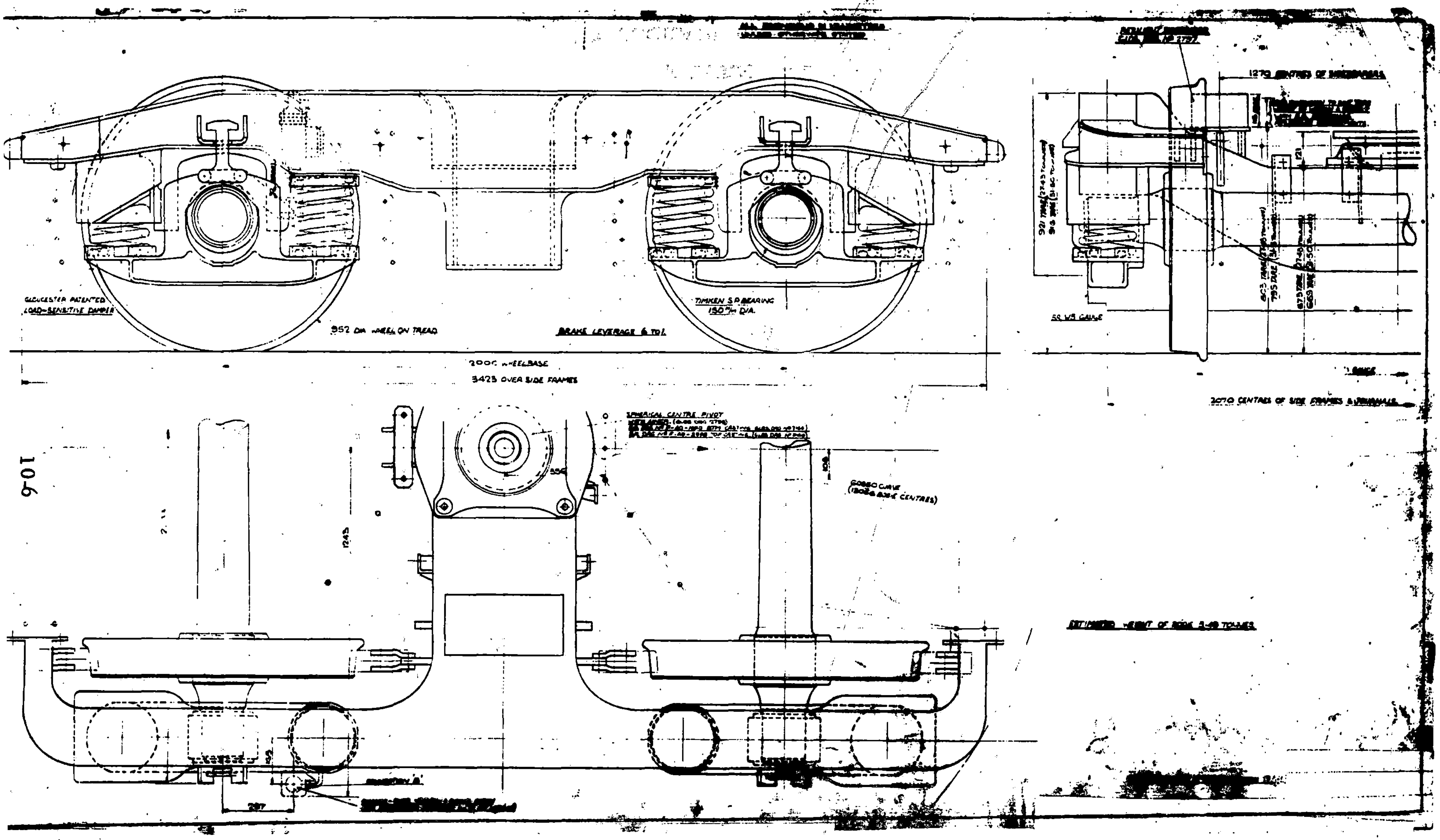


FIGURE 10-1

GLOUCESTER GPS-25 TRUCK

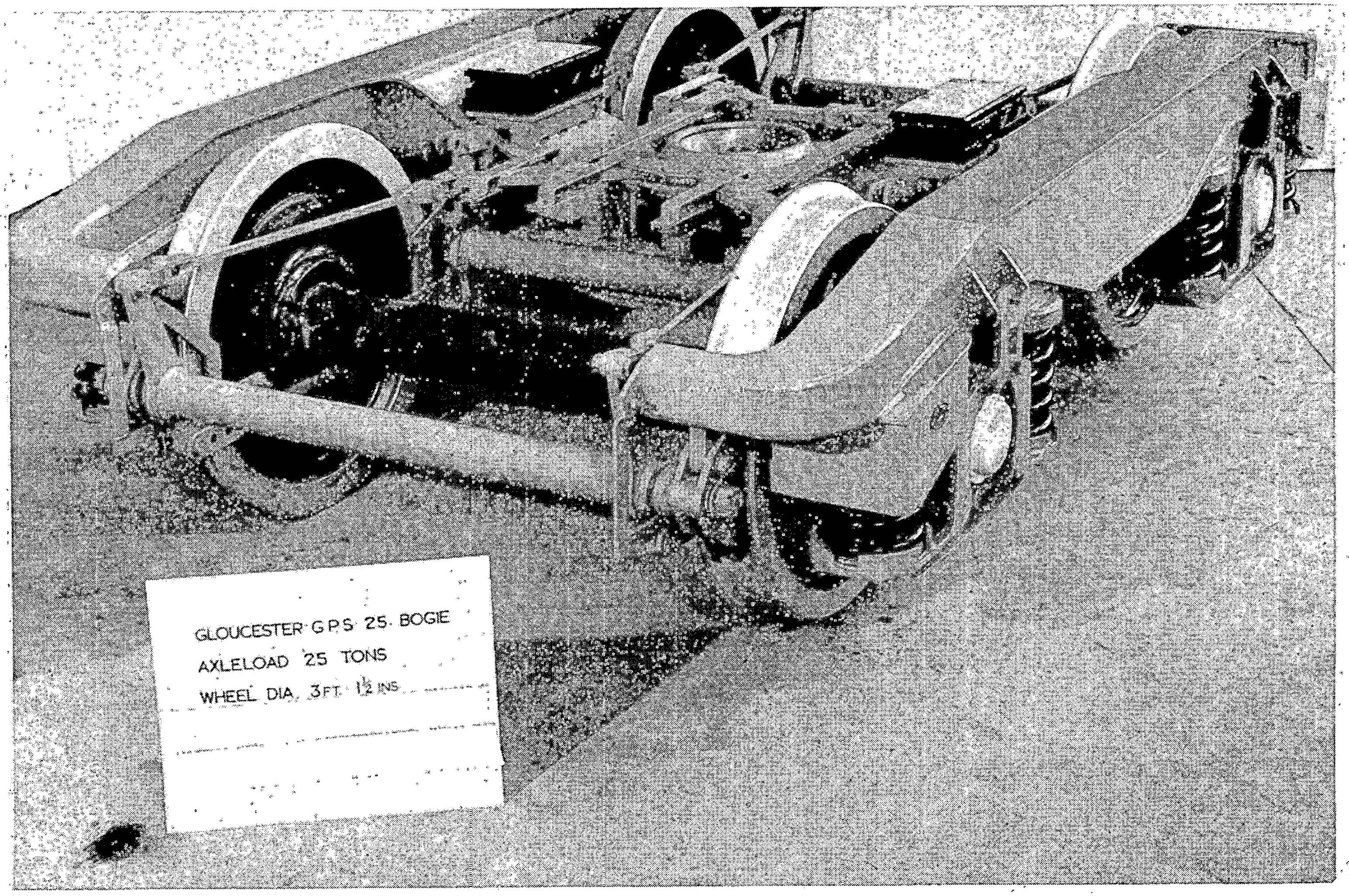
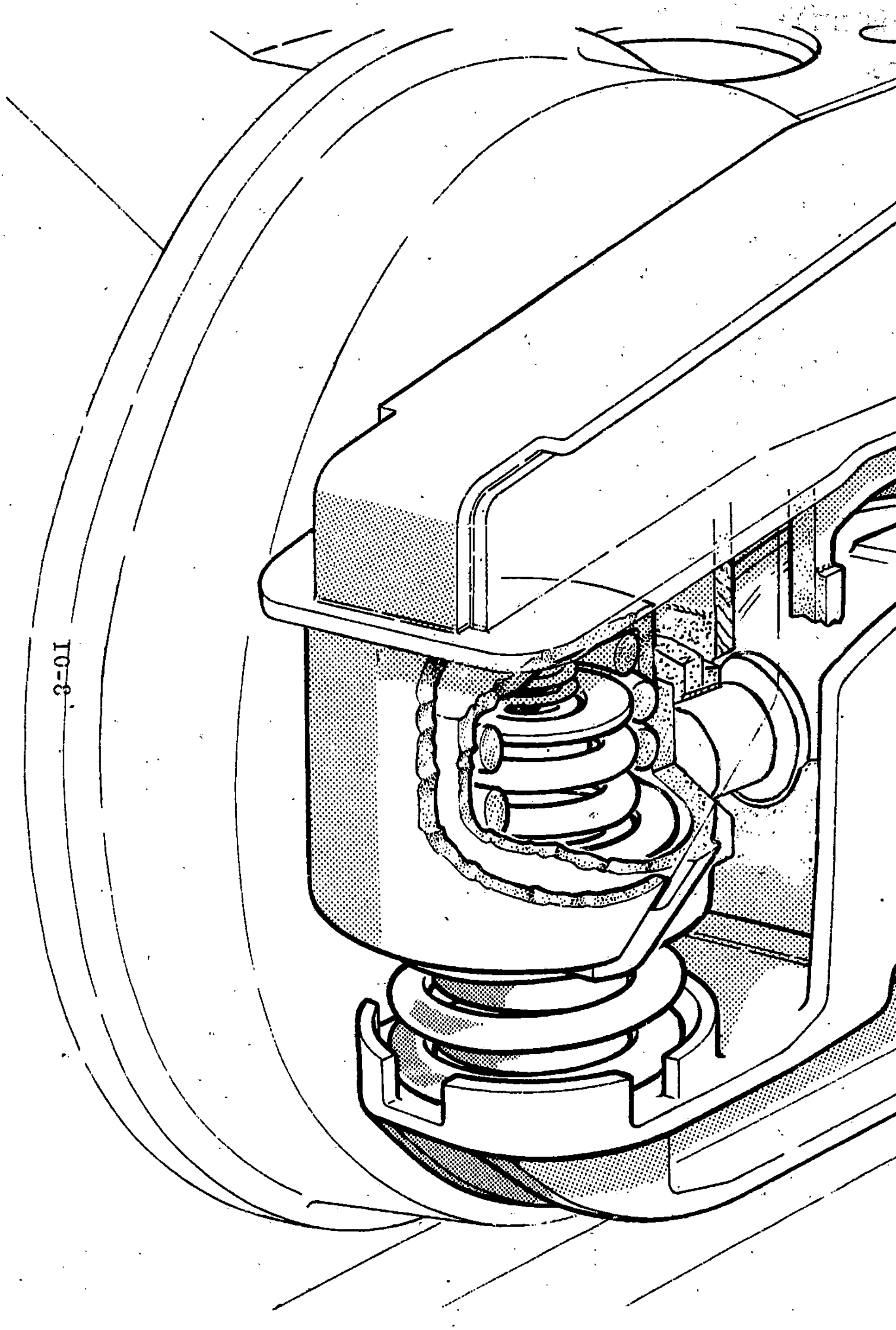


FIGURE 10-2

PHOTOGRAPH GPS-25 TRUCK



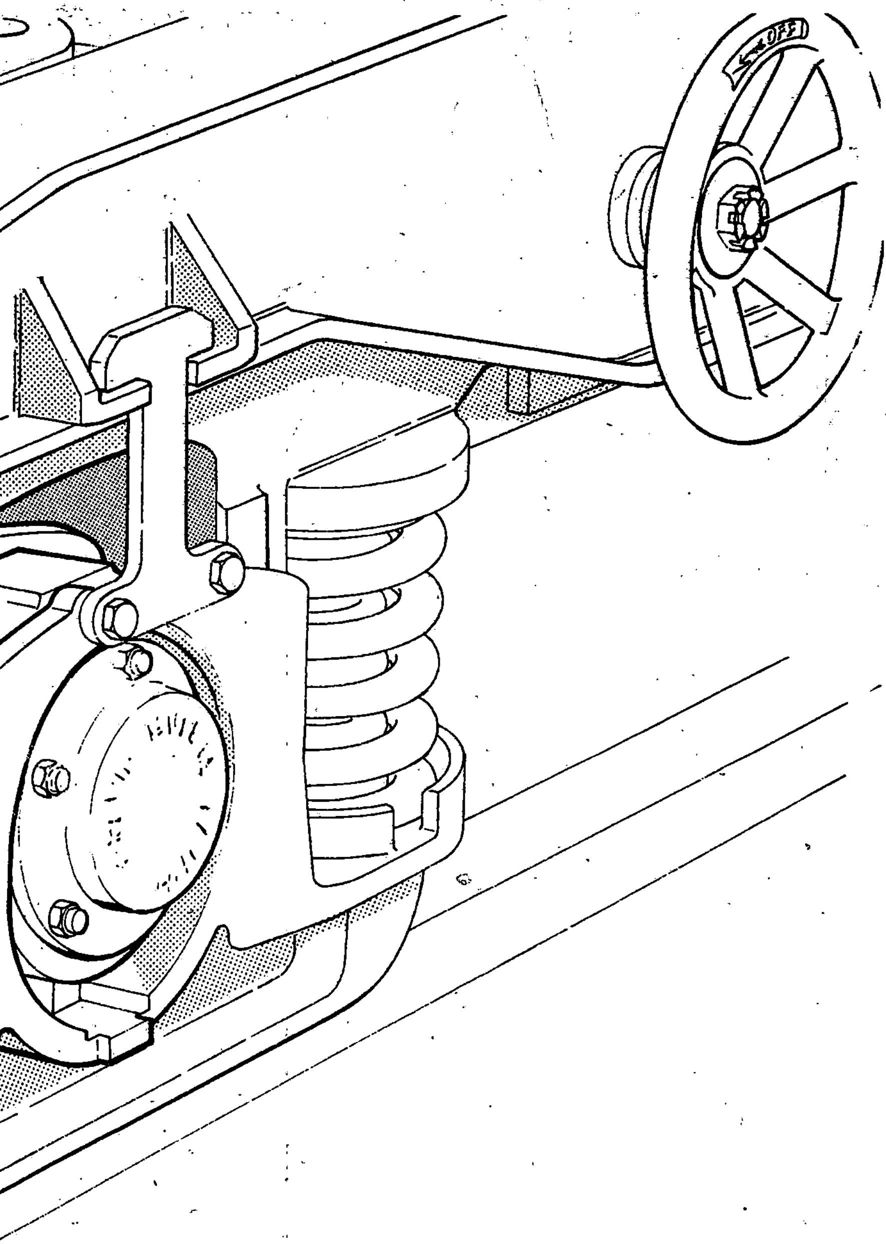


FIGURE 10-3
LOAD SENSITIVE SNUBBER

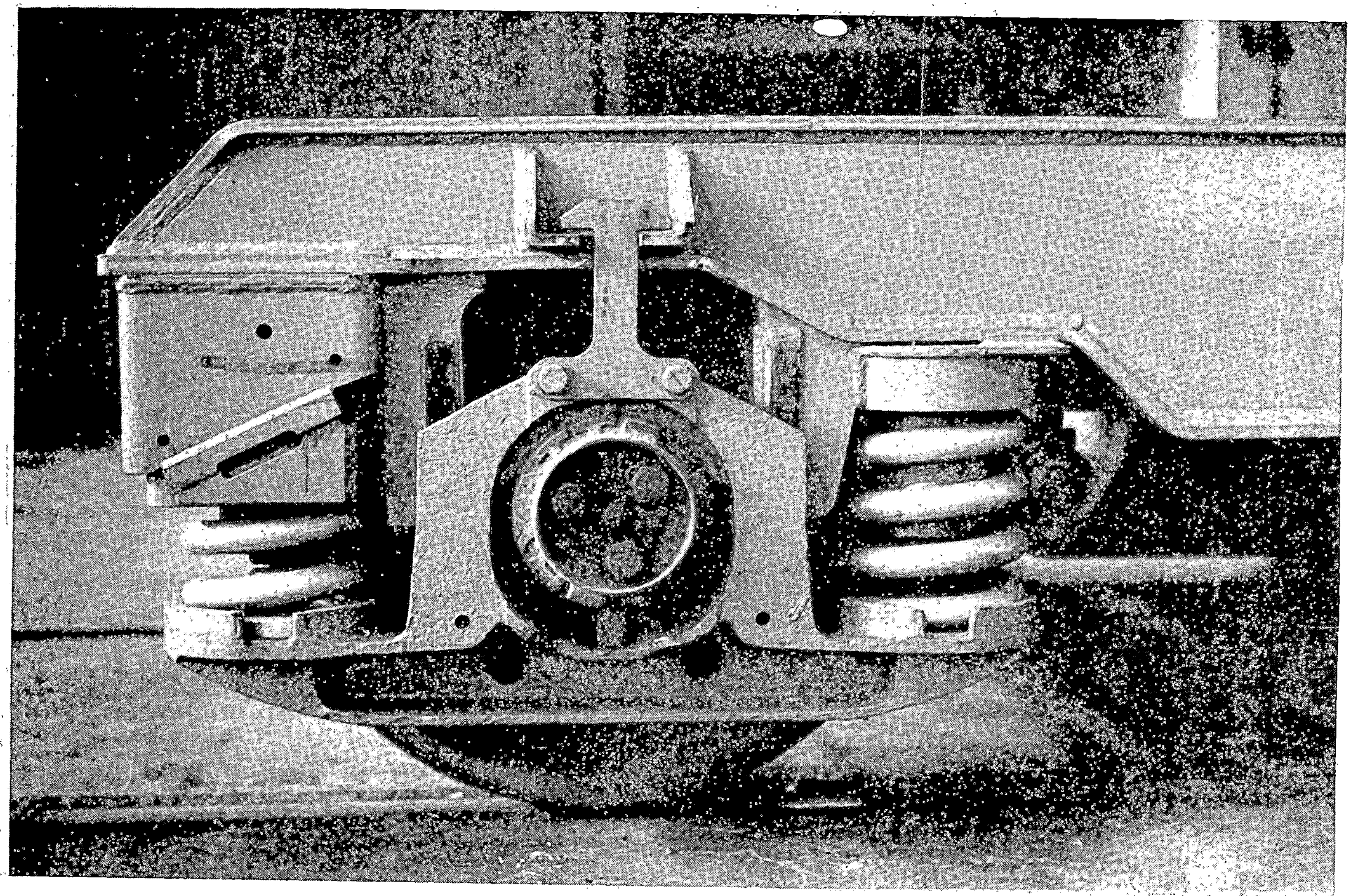


FIGURE 10-4

AXLE BOX ARRANGEMENT

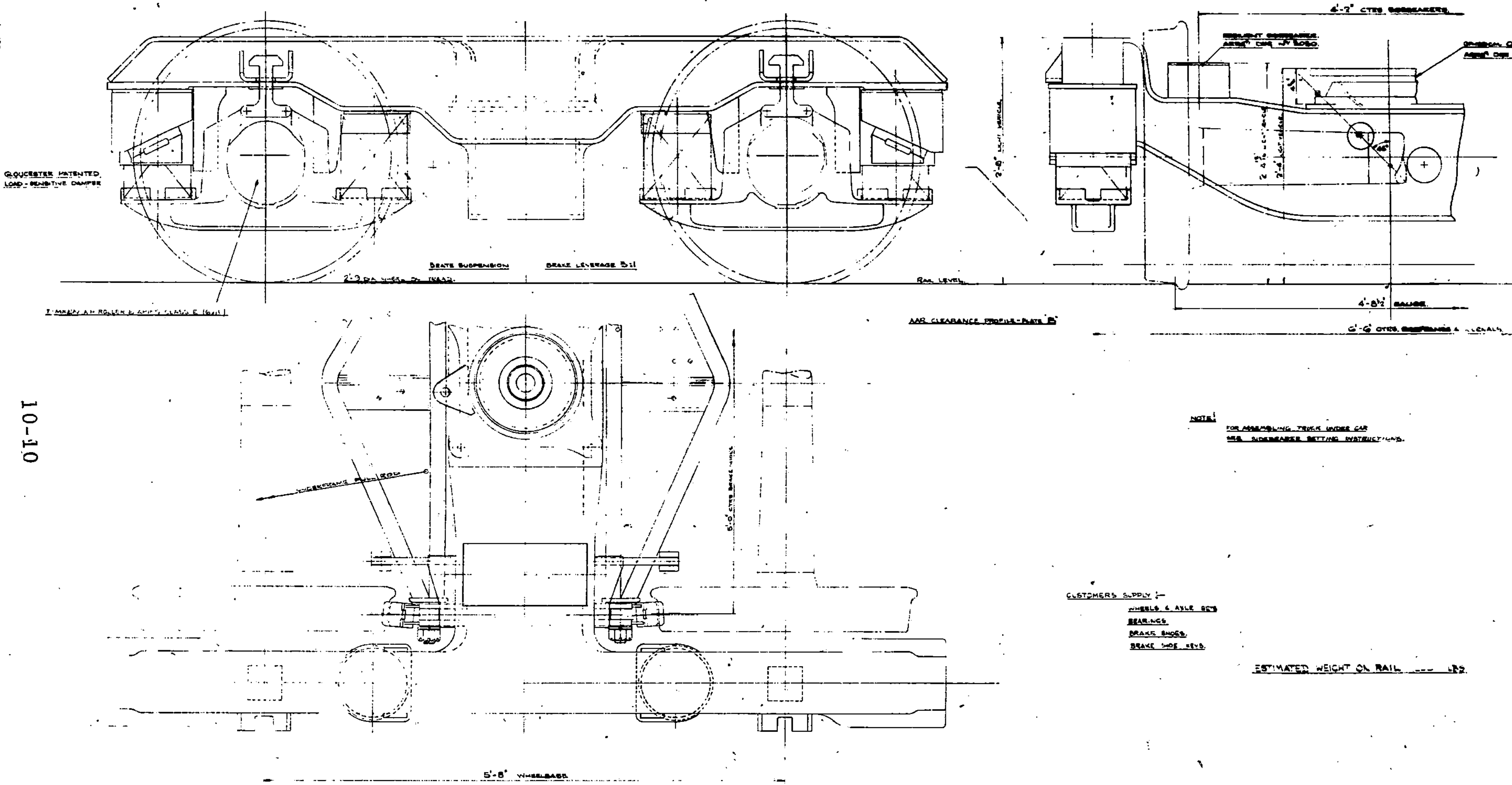


FIGURE 10-5

ARRANGEMENT - AMERICANIZED DESIGN

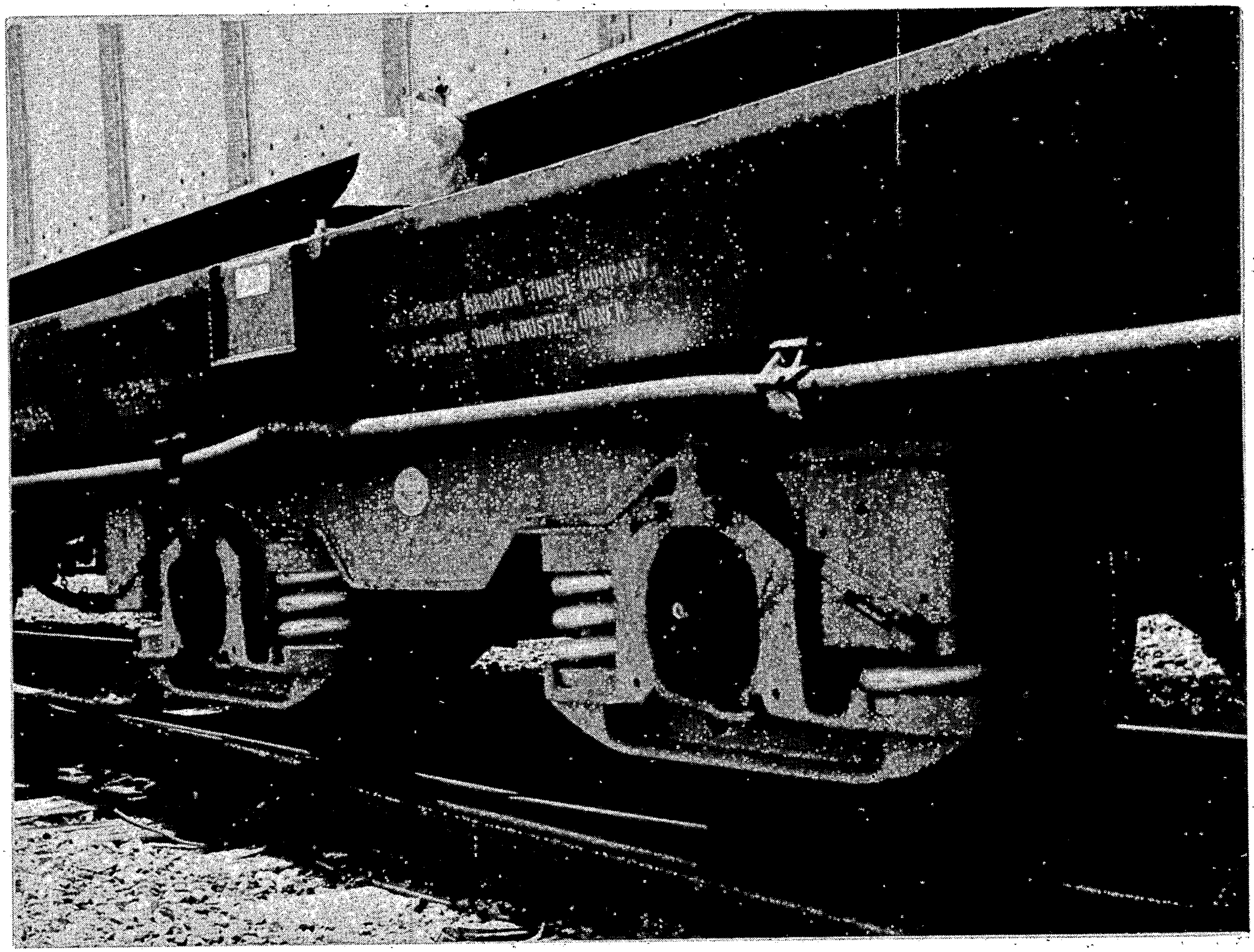


FIGURE 10-6
TRAILER TRAIN APPLICATION GPS-25

Section 11

SYMINGTON XL TRUCKS

11.1 TECHNICAL

The Symington XL truck was first produced by the Symington Wayne Corporation in 1946 in a 50-ton capacity, solid bearing design. In 1965, they started producing the 70-ton capacity, roller bearing version known as the XL-70.

The truck is made up of two cast-steel side frames connected by a cast-steel bolster arranged in a conventional manner. It has a primary spring arrangement using separate journal housings, each with supporting coil springs and friction elements. Arrangement of the XL-70 truck is shown in Figures 11-1 and 11-2.

The journal housings are provided with side brackets which mount two long travel coil springs that support the pedestal-type side frames as shown in Figure 11-3. The legs of the pedestal jaws of the side frames provide recessed channel walls. The inside vertical walls are provided with hardened wear plates, and an expanding-type friction arrangement is carried against the side of each journal box. A horizontal section of this arrangement is shown in Figure 11-4.

The friction arrangement is constrained to move vertically with the box, but is free to move laterally. The friction springs within the snubber shoes expand these shoes against the angled walls of the pedestal jaw wear plates. The pressure between the friction shoes and the pedestal wear plates, with resulting friction, controls vertical movement. The effect of the slope of the angled sides of the jaw is to create a force component acting between the face of the friction shoes and the liners on the sides of the box. This component is lower than the pressure against the sides of the pedestal jaw liners and is sufficient to give some control of lateral movement, but does not delay restoration of the journal box to its normal position laterally. The arrangement provides 1-1/4-inch total lateral motion and gives a measure of control laterally as well as effective vertical snubbing.

The truck is held in tram by a locking arrangement between the side frames and bolster and is maintained within a small variation by a close fit between bolster end flanges over the center member of the side frame. This locking arrangement is shown in Figure 11-5.

The side frames can function as equalizers by being free to rock fore and aft in relation to the bolster to maintain equal deflection of all pedestal springs regardless of track irregularities. The rocking of the bolster on the side frame member is permitted by providing a large radius on the end of the bolster where it contacts the side frames.

The trucks are designed for standard hanger type brake beams and usually provided with conventional roller side bearings. Assembly and disassembly is reasonably simple and is performed essentially the same as conventional freight car trucks.

11.2 FEASIBILITY

After considerable testing by Symington Wayne during the design period, the first "XL" trucks were placed in service in 1946 and 135 sets of 50-ton-capacity trucks were put in service from 1947 through 1963. A survey conducted in 1963 indicated that of the 135 sets, 133 remained in service. The trucks were applied to various types of cars: box, gondola, stock, baggage express, and refrigerator express.

The PFE Company's express refrigerator cars equipped with these trucks in 1948 were later downgraded to general freight service and continued in use for the remaining life of the cars. The trucks were then transferred to newer cars and kept in service for several additional years. It is estimated that these trucks accumulated in excess of one million miles and maintenance costs were confined mostly to wheels, bearings, and brake parts.

Based on success of the original 50-ton-capacity truck, the XL-70 truck was introduced in 1965. Ten car sets were applied to mechanical refrigerator cars and in 1966 thirty-five car sets applied to Flexi-Van piggyback flat cars (for container mail movement) used in head-end, high-speed service. Also, ten car sets were applied to Southern Pacific Auto Rack cars in the 515000 series between May and October of 1970.

These applications have proven this approach to be an entirely feasible and a stable design.

11.3 SERVICE EXPERIENCE

The ten car sets applied to mechanical refrigerator cars were released for service in May 1965 as part of Pacific Fruit Express Company's test program to evaluate various types of improved trucks for perishable service. Results of this test showed that ride qualities were considerably better than conventional trucks and the service test has shown that the trucks are (with the exception of wheels) essentially "maintenance free" as compared to conventional freight car trucks. The ten car sets remain in service under refrigerator cars and are available for inspection. They have now accumulated approximately 500,000 miles.

Two of the car sets that were applied to the Southern Pacific Auto Rack cars in 1970 were carefully measured prior to application and in March of 1974 a complete truck inspection was conducted on SP 515081 at Southern Pacific Sacramento shop. This inspection included a complete teardown, with detail measurement of both trucks, and it indicated a projection of between 400,000 and 500,000 miles before any maintenance would be required due to wear. This test is covered by Dresser Transportation Division's report TE-1970-2, dated March 1974.

There have been 135 car sets of 50-ton capacity and 511 car sets of 70-ton capacity trucks applied and service experience has shown them to be safe and comparatively trouble free.

11.4 AVAILABILITY

The truck is manufactured by the Dresser Transportation Equipment Division of Dresser Industries, Inc., of Depew, New York and has, in the past, been available from them. The XL-70 truck is currently not available, however, because of tooling changes required to produce it in their Depew foundry. It was last produced in Canada for the CNR container vehicles. Dresser does have one car set that could be made available for test purposes.

11.5 COST FACTORS

First cost of the XL trucks has, in the past, been about double that of conventional freight car trucks and this differential would probably continue unless it could be manufactured in very high volume. The heavy castings would need to be made obtainable from all manufacturers of cast-steel side frames and bolsters.

Precise maintenance costs are not available; however, service experience has indicated that, with normal maintenance, the trucks will last for the life of the car and that maintenance costs would be markedly reduced below those of conventional freight car trucks. Indirect related costs, such as time out of service for repairs, lading damage, rail wear, derailments, etc., would also be reduced.

More precise maintenance cost figures could be obtained by making a study of wear rates on a few of the trucks under the PFE refrigerator cars or the SP Auto Rack cars as compared to conventional trucks under cars of the same vintage and service experience.

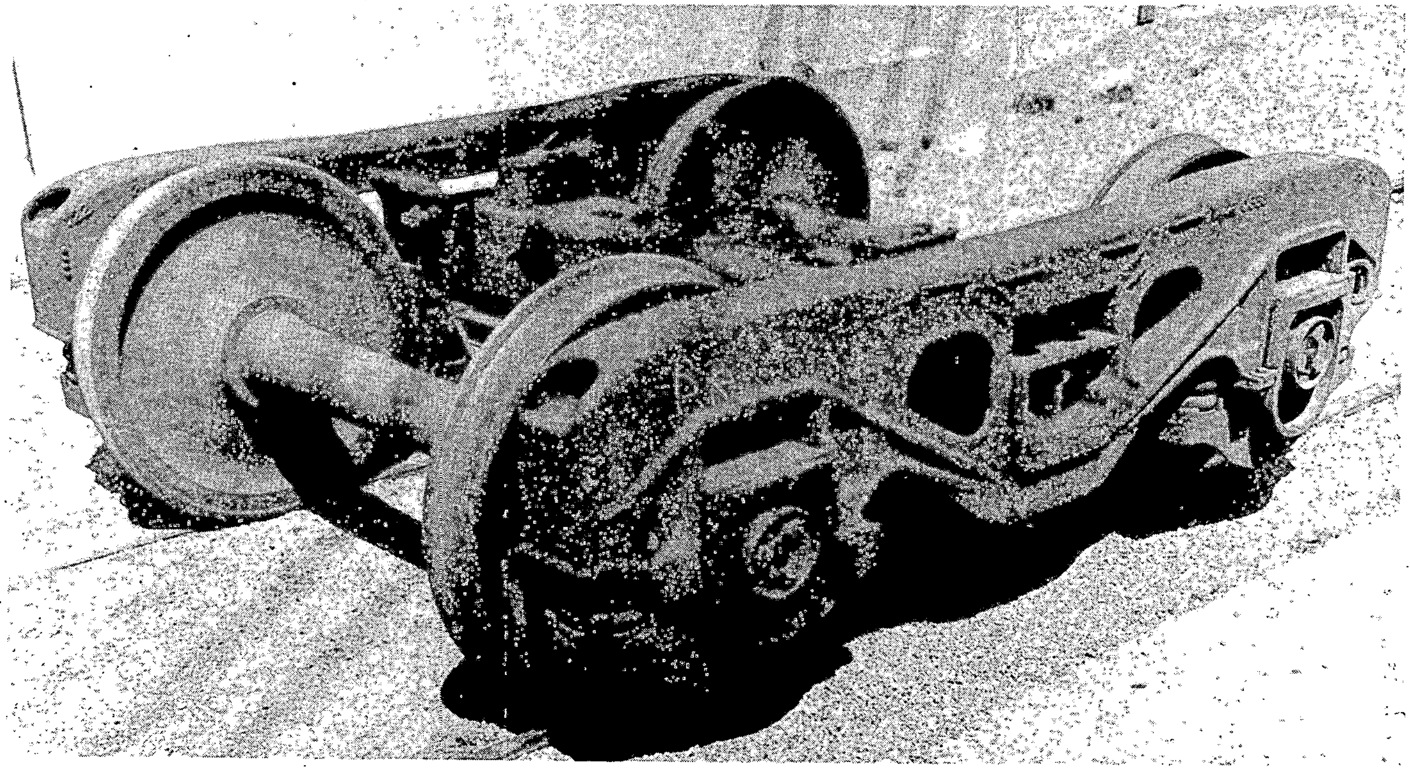
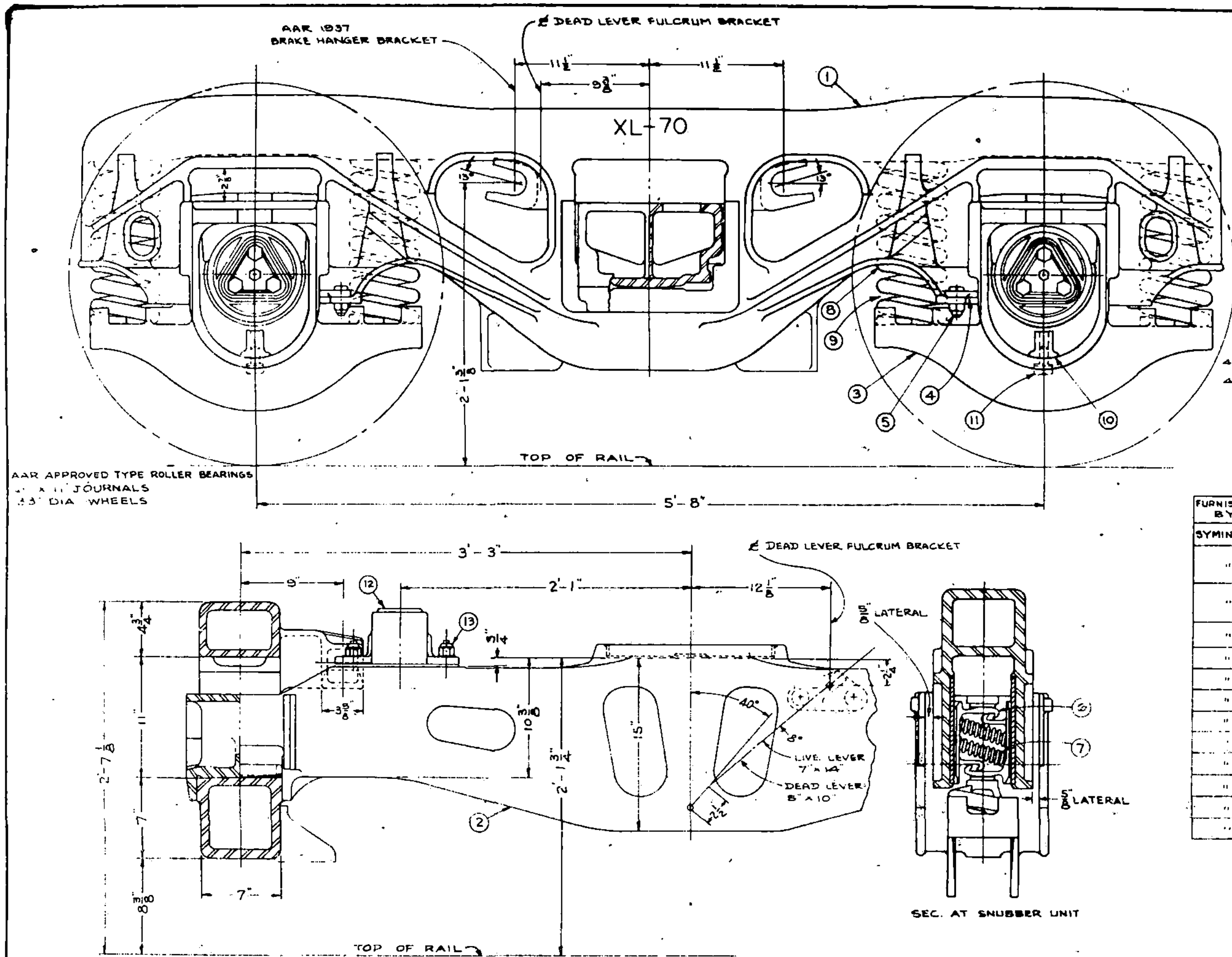


FIGURE 11-1

SYMINGTON XL-70 TRUCK



SPRING DATA PER SIDE FRAME
FRAME SOLID ON JOURNAL HOUSING
3 5/8" TRAVEL SPRING GROUP

4-OUTER COIL SPRINGS (6 1/8" O.D. x 1 1/4") 54,912
4-INNER COIL SPRINGS (3 1/2" O.D. x 13/16") 30,600
TOTAL CAPACITY 85,512 LBS.

FURNISHED BY	NO PER CAR	PATT. NO. OR SHAPE NO.	DWG. NO.	DESCRIPTION	ITEM NO.
SYMINGTON	4	TF-7200-HT	TF-7200-2	SIDE FRAME WITH LINERS APPLIED	1
"	2	BO-7451-HT	BO-7451-2	BOLSTER WITH DEAD LEVER FULCRUM BRACKET	2
"	8	5-S-33-S-HT	P-851	ROLLER BEARING JOURNAL HOUSING WITH LINERS APPLIED	3
"	16	4113	N-3475	JOURNAL HOUSING RETAINING PLATE	4
"	16	4119	Y-1050	5/8" BOLT & NUT	5
"	32	H-298 A	R-8153	SNUBBER SHOE	6
"	32	6085	N-3290	SNUBBER SPRING	7
"	16	6375	R-8191	OUTER COIL SPRING	8
"	16	6376	R-8192	INNER COIL SPRING	9
"	8	4114	Y-1045	RETAINING BLOCK	10
"	8	4061	Y-971	CAP SCREW & LOCK WASHER	11
"	4	RSB-13	R-7390	RESILIENT SIDE BEARING	12
"	12	———	———	3/4" BOLT - 5" LONG & SELF LOCKING NUT	13

220,000 LBS. MAX. RAIL LOAD

MATERIAL	PATTERN NO.

SYMINGTON WAYNE CORPORATION
SYMINGTON DIVISION

HIGH SPEED TRUCK ASSEMBLY
TYPE XL-70
WITH ROLLER BEARING JOURNAL HOUSINGS
6" X 11" JOURNALS

APPROVED
R-8632
DEPEW, N.Y.
OCT 12, 1967

THE DEVICES AND PARTS SHOWN HEREON ARE COVERED BY PATENTS AND PENDING APPLICATIONS OWNED OR CONTROLLED BY SYMINGTON WAYNE CORPORATION OR UNDER WHICH SYMINGTON WAYNE CORPORATION IS LICENSEE.

SYMINGTON WAYNE CORPORATION RESERVES THE RIGHT TO MODIFY DETAILS NOT AFFECTING APPLICATION OR STRENGTH IF NECESSARY TO FACILITATE MANUFACTURE.

DR GLW.
TR
CH

FIGURE 11-2

TRUCK ARRANGEMENT XL-70

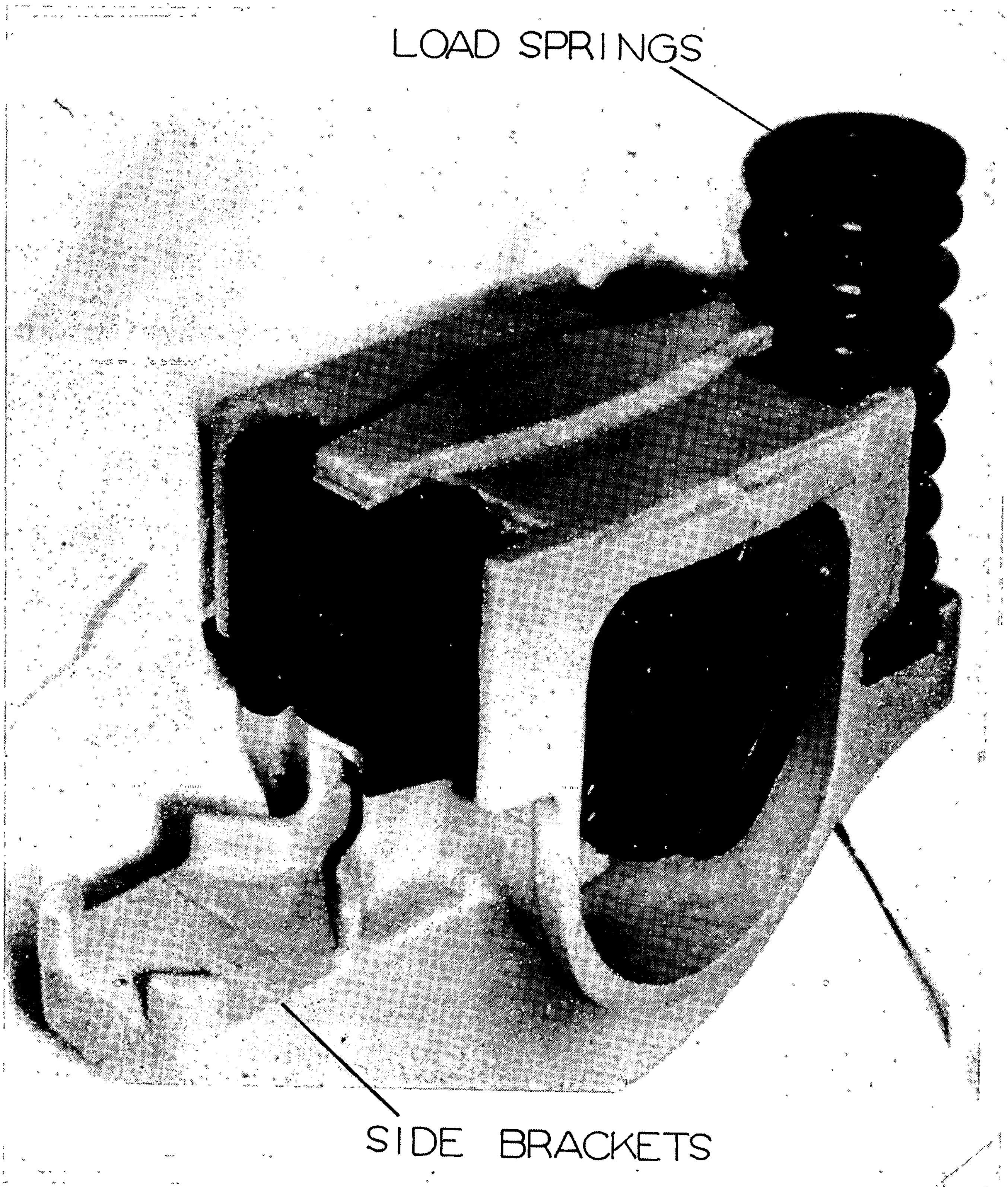


FIGURE 11-3

AXLE BOX ASSEMBLY

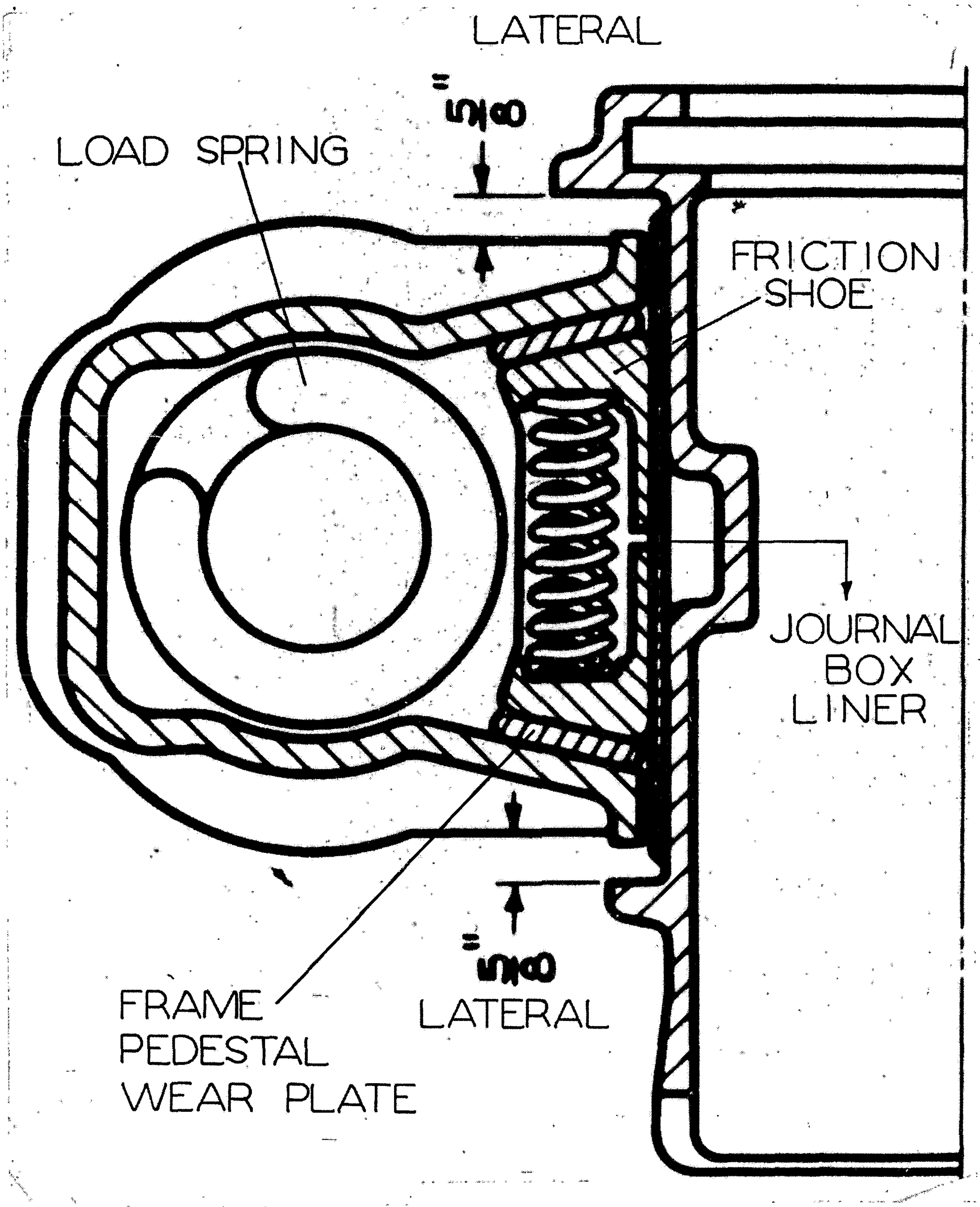


FIGURE 11-4

FRICTION ELEMENTS

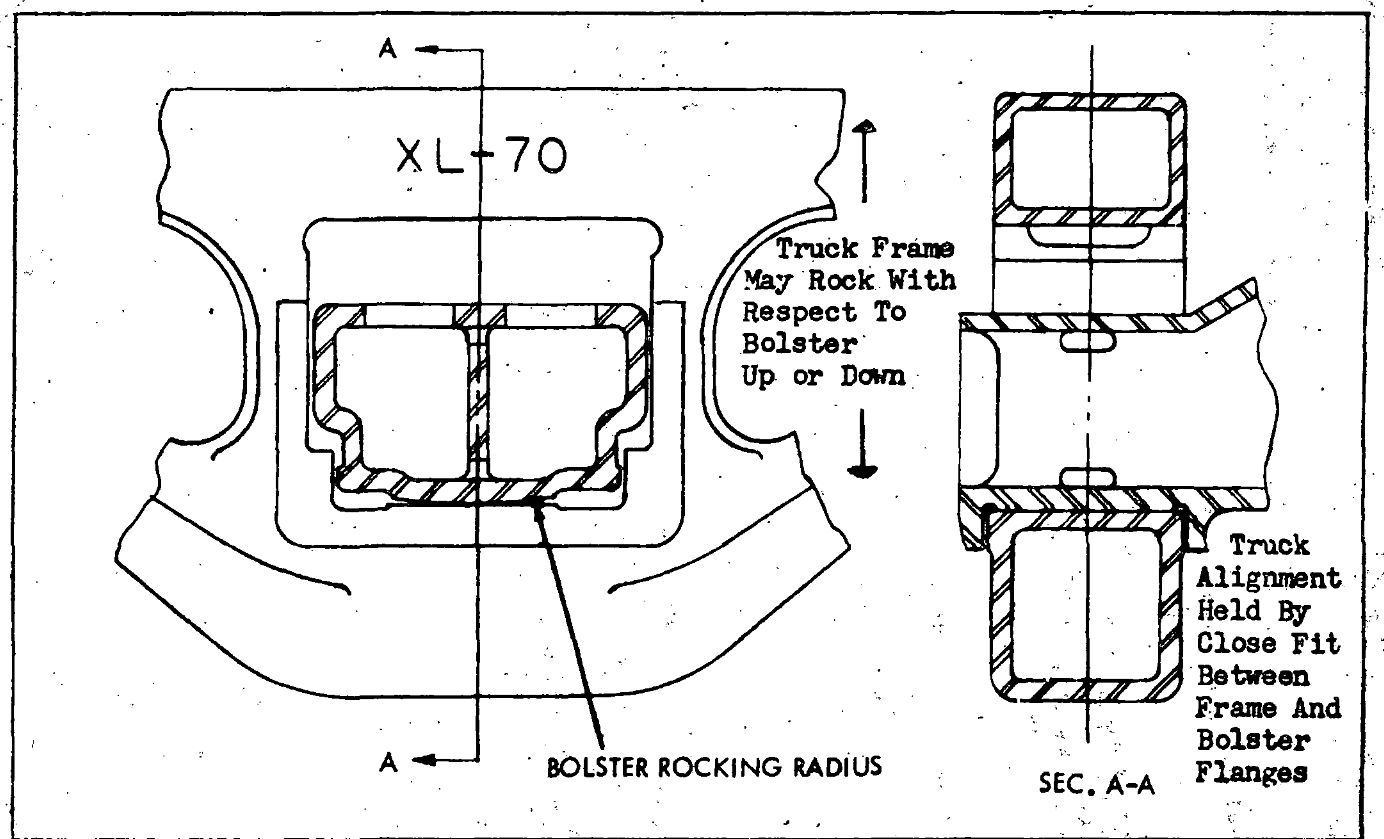


FIGURE 11-5

SIDE FRAME AND BOLSTER LOCK

Section 12

ANCHOR TRUCK

12.1 TECHNICAL

The Anchor truck is a joint development between the South African Railways and Standard Car Truck Co. The truck consists of cast-steel side frames and bolster arranged in a conventional manner, using a secondary spring arrangement. It utilizes conventional brake rigging and the "Barber" snubbing device. The South African Railways' version is designed for a 3-ft., 6-in. gauge and the trucks are scaled accordingly.

The unique feature of the design consists of diagonally placed anchors which connect special adapters of diagonally opposite axle boxes. These anchors pass through existing openings in a conventional cast-steel bolster. An additional adapter is provided similar to conventional axle boxes used with primary spring arrangements (that goes over the conventional roller bearing adapter) which supports the side frames on two elastomer pads and provides a connection to the anchors. A measure ($\pm$ 1/2 in.) of controlled lateral motion is obtained by reaction of the elastomer pads in shear.

The diagonal anchors perform the function of stabilizing the truck to ground to control unstable hunting, but at the same time do not interfere with the natural tendency of profiled wheels to align themselves radially on a curved track. Ample clearance is provided in the longitudinal direction between the special adapters and the pedestal opening of the side frame to allow the axles to assume a radial position on all curves. The cross anchors must transmit the brake forces which tend to push the two wheel sets apart and to ensure that this does not result in unacceptably high stresses in the anchors and adapters, ties are fitted between to two special adapters on the same axle. The diagonal anchors are not steering devices. Steering is obtained entirely by the natural ability of profiled wheel sets to align themselves and the anchors do not interfere with this curving ability. An arrangement of the South African Railways' version is shown in Figure 12-1.

12.2 FEASIBILITY

The South African Railways have about one hundred cars equipped with conventional trucks in unit train service transporting iron ore from the Northern Cape to the harbor at Port Elizabeth, a distance of about 600 miles (1,000 km). Near Port Elizabeth, the line drops sharply from the inland plateau to sea level. Long downgrades of 1 in 80 and curves of 120 ft. to 150 ft. radius are encountered. The cars make the downgrade loaded and return empty.

The SAR has had an expensive problem with flange wear on this run and has found that after only nine round trips (12,000 mi.) the wheel contour needs to be restored by machining. They use multi-wear wheels which permit about three turnings.

They also investigated ride performance of the conventional three-piece truck and found that this truck would develop unstable hunting characteristics under loaded conditions at about 55 mph (92 km/h) and at 45 mph (75 km/h) when empty. This compares closely to findings with the same design truck, but of 4-ft., 8-1/2 in. gauge in the United States.

The SAR conducted considerable investigation into the natural ability of a conical wheel set to negotiate a curved track in a pure rolling motion in the belief that if unconstrained wheel sets can be accomplished in a suspension system, the wheel sets would tend to keep the axles at right angles to the track on tangent track and seek the radial position on curved track.

Early experiments indicated that their theory, as confirmed by numerous computer programs, was correct, but unstable hunting on tangent track continued to exist at about the same speeds. It was then decided to tie the axle boxes together diagonally in order to hold the side frames in tram to minimize unstable hunting. Further tests indicated that unstable hunting at speeds up to 80 mph (133 km/h) was eliminated.

The SAR then equipped one car with trucks designed with the diagonal anchors for comparison with conventional three-piece trucks as well as comparison with several car sets of the UIC bogie (French).

After the same nine trips referred to above, the flange wear was not measurable on wheels in trucks with diagonal anchors. The car has now accumulated approximately 50,000 miles (83,500 km) and condition of lead wheels on the modified trucks indicates that the problem of excessive wheel flange wear has been virtually eliminated with this design.

The SAR claim the following results for this design:

- Stability of the modified trucks is materially improved and unstable hunting is virtually eliminated
- This improved stability is maintained at a full range of speeds and under varying load conditions
- Wheel flange wear is dramatically reduced

Test results indicate that in order to maintain this performance, it is important to keep wheel tread profiles constant during life of the vehicle as stability declines rapidly with wheel-worn-hollow conditions.

Standard Car Truck Co. is testing the device in the United States under a 100-ton coal hopper car and results to date confirm findings of the South African tests. A photograph of the S.C.T. Co. 100-ton truck now under test is shown in Figure 12-2.

Tests run by South African Railways in Africa and by Standard Car Truck Co. in the United States indicate that the design is feasible and will operate safely under the varying conditions of general freight car service.

12.3 SERVICE EXPERIENCE

The trucks are still in the test stage and other than the experimental prototypes referred to in Paragraph 12.2, have had no service experience.

12.4 AVAILABILITY

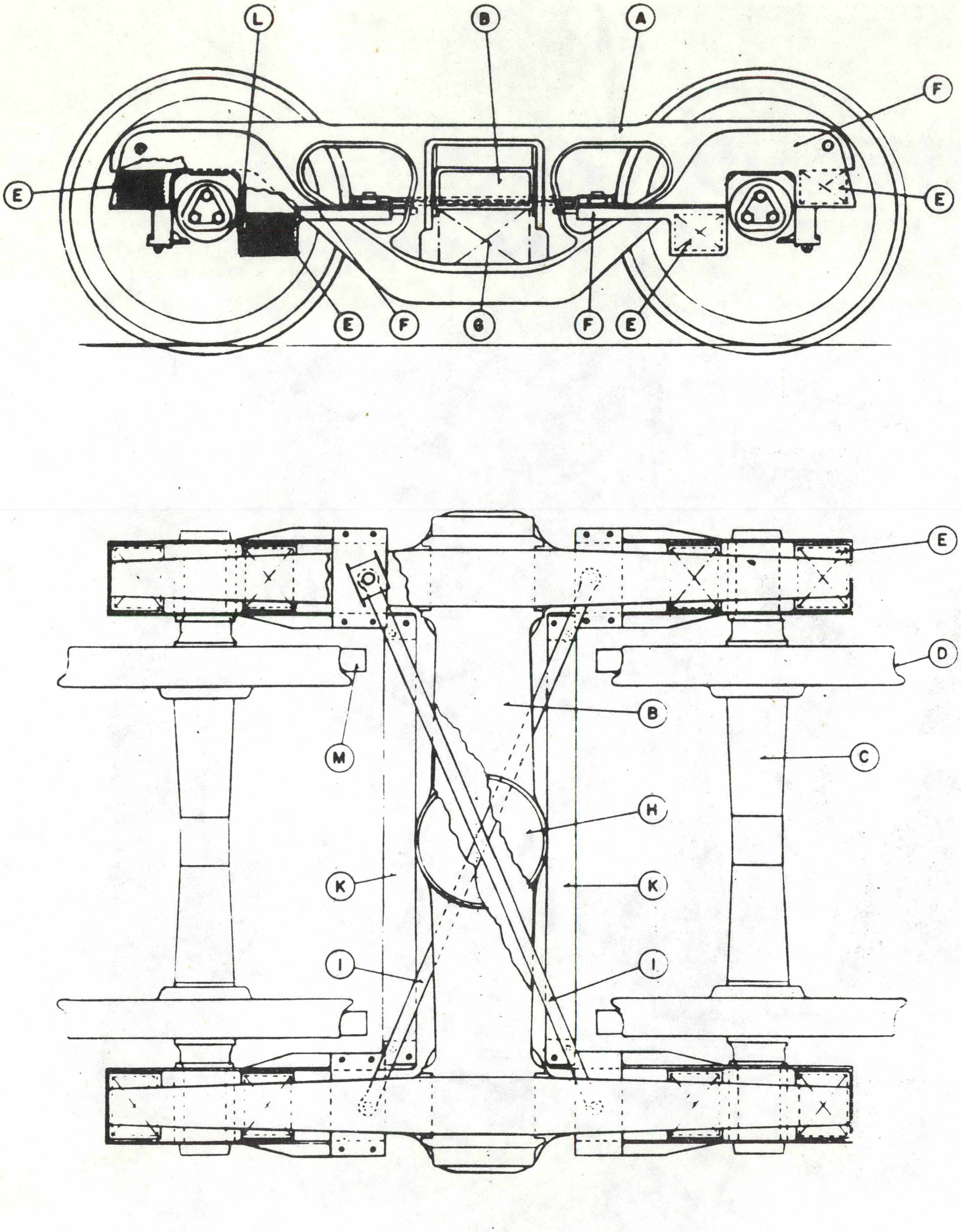
The trucks would be a proprietary item of Standard Car Truck Co. in the United States and special items would be available from this company. Heavy castings (side frames and bolsters) would be available from all truck casting manufacturers in the same manner as existing "Barber" trucks.

12.5 COST FACTORS

First cost of the South African design (3-ft., 6-in. gauge) is estimated at approximately $1,200 per car set over a conventional three-piece design. S.C.T. Co. estimate is about the same for a 4-ft., 8-1/2 in. gauge version.

Cost figures for maintenance experience are not available; however, if design goals are met as indicated by tests, then maintenance costs should be materially reduced.

It should be possible to arrive at reasonably accurate maintenance costs by application of formulae developed by the TDOP Economic Study.



A : load carrying side frames;
B : bolster;
C : wheelset;
D : profiled wheel tread;
E : rubber sandwiches;
F : axle box adaptor;
G : bolster springs;
H : centre pivot;
I : cross-anchor;
K : stay;
L : longitudinal clearance between adaptor and side frame;
M : single brakes.

FIGURE 12-1

ANCHOR TRUCK ARRANGEMENT

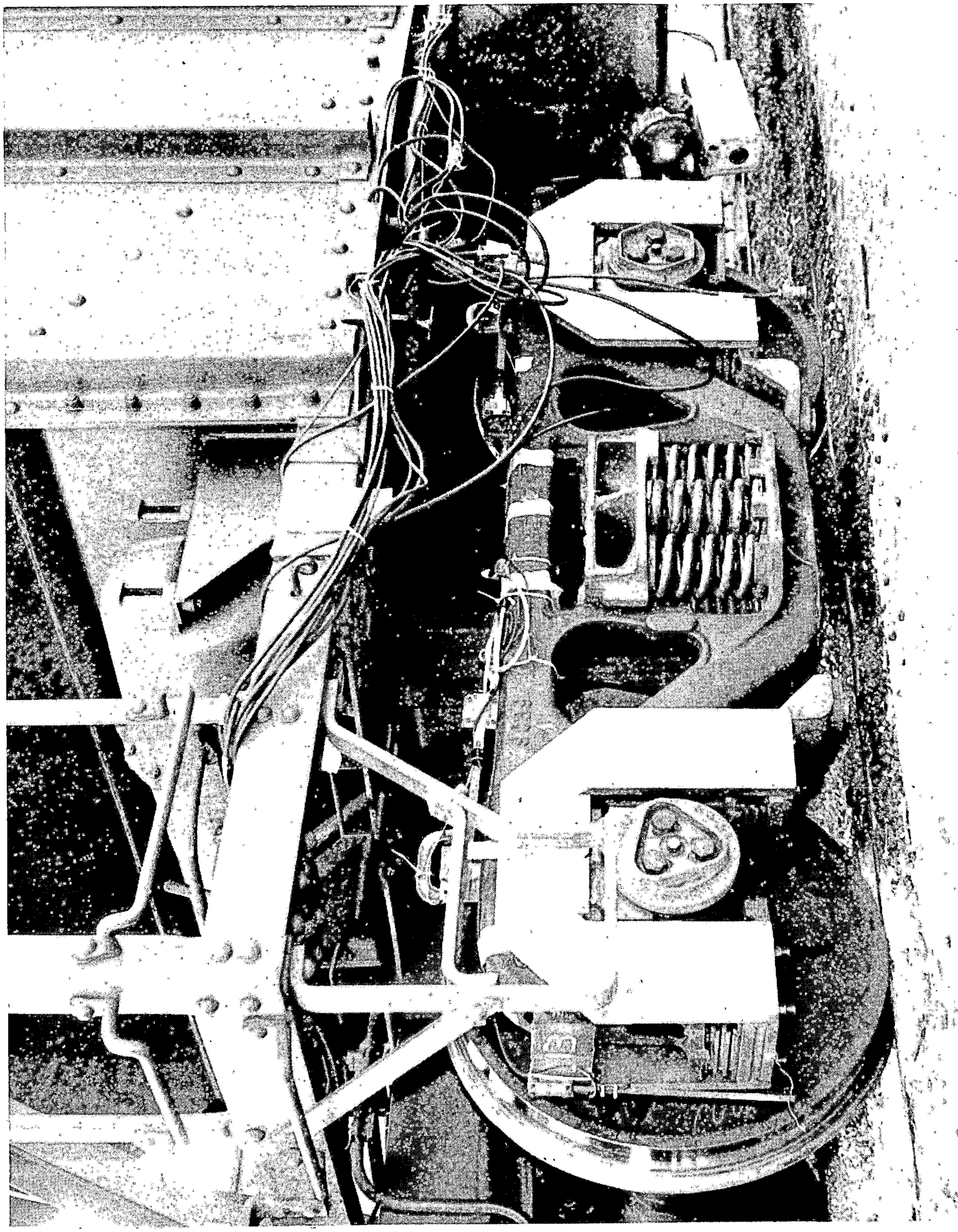


FIGURE 12-2

ANCHOR TEST TRUCK

Section 13

C-PEP DEVICE

13.1 TECHNICAL

The name "C-PEP" is an acronym for "Center Plate Extension Pad" and identifies a development by Standard Car Truck Co. consisting of elastomeric pads located immediately outboard of the car center plate. The shear characteristics of the pad develop a yaw spring/damper between the truck and car body, thus providing rotational control. Vertically, the pad's high spring rate gives an effective static and dynamic couple between the car body mass and truck suspension system.

The center plate extension pad was originally marketed as a control for "rock and roll;" however, subsequent tests indicated that the device also had a material improvement on unstable hunting due to its shear characteristics on truck swivel. This result is similar to constant-contact side bearings.

C-PEP is a development for application to conventionally designed trucks, both as a modification to existing cars and as an application to conventional trucks applied to new equipment. Figure 13-1 is a photograph showing the relationship of the mating surfaces of the C-PEP pads to the side bearings and truck center plate. Figure 13-2 shows the device in place.

The pads are preloaded by the use of shims placed under them at assembly which results in pressure being applied immediately as the car reacts to an irregular truck action. Control of "rock and roll" is accomplished by the car sway compressing the C-PEP pads which activate the friction snubbers of the truck immediately, rather than after the normal side bearing closures when a dynamic force has been developed.

13.2 FEASIBILITY

The manufacturer states that C-PEP requires no post-application adjustment and is "fail-safe." The device has been service tested on numerous railroads and has improved 70- and 100-ton car ride quality for the full range of equipment, from flat cars through high center of gravity, large box and hopper cars.

Approximately 300 C-PEP-equipped cars have been in service since 1967 and none have had a reported derailment due to "rock and roll." Wheel wear is being monitored and evidence indicates increased wheel life in all cases.

All test reports and service experiences have shown the device to be entirely feasible.

13.3 SERVICE EXPERIENCE

C-PEP has been in service since 1967 and there have been over 25,000 cars so equipped placed in service since that date. Unit train trucks, inspected after approximately 500,000 miles of service, show a minimum of wear between bolster gibs and side frames. Side bearings and their contact plates show evidence of only light impacts. Service experience to date amounts to approximately 125 million miles without any serious problems developing.

13.4 AVAILABILITY

The device is available from Standard Car Truck Co. Bolsters modified for the device are available from all regular suppliers of heavy castings and all major car builders are equipped to apply C-PEP on a customer's order.

13.5 COST FACTORS

The C-PEP device costs approximately $650.00 per car set applied to existing cars and approximately $210.00 per car set applied to cars as they are built. It is estimated that wheel life is improved approximately 20 percent and center plate life is doubled. Wear on bolster gibs and other truck parts is also reduced.

Based on the best available records, it appears the elastomer pads last a minimum 500,000 miles and with no measurable wear on the body bolster wear plate.

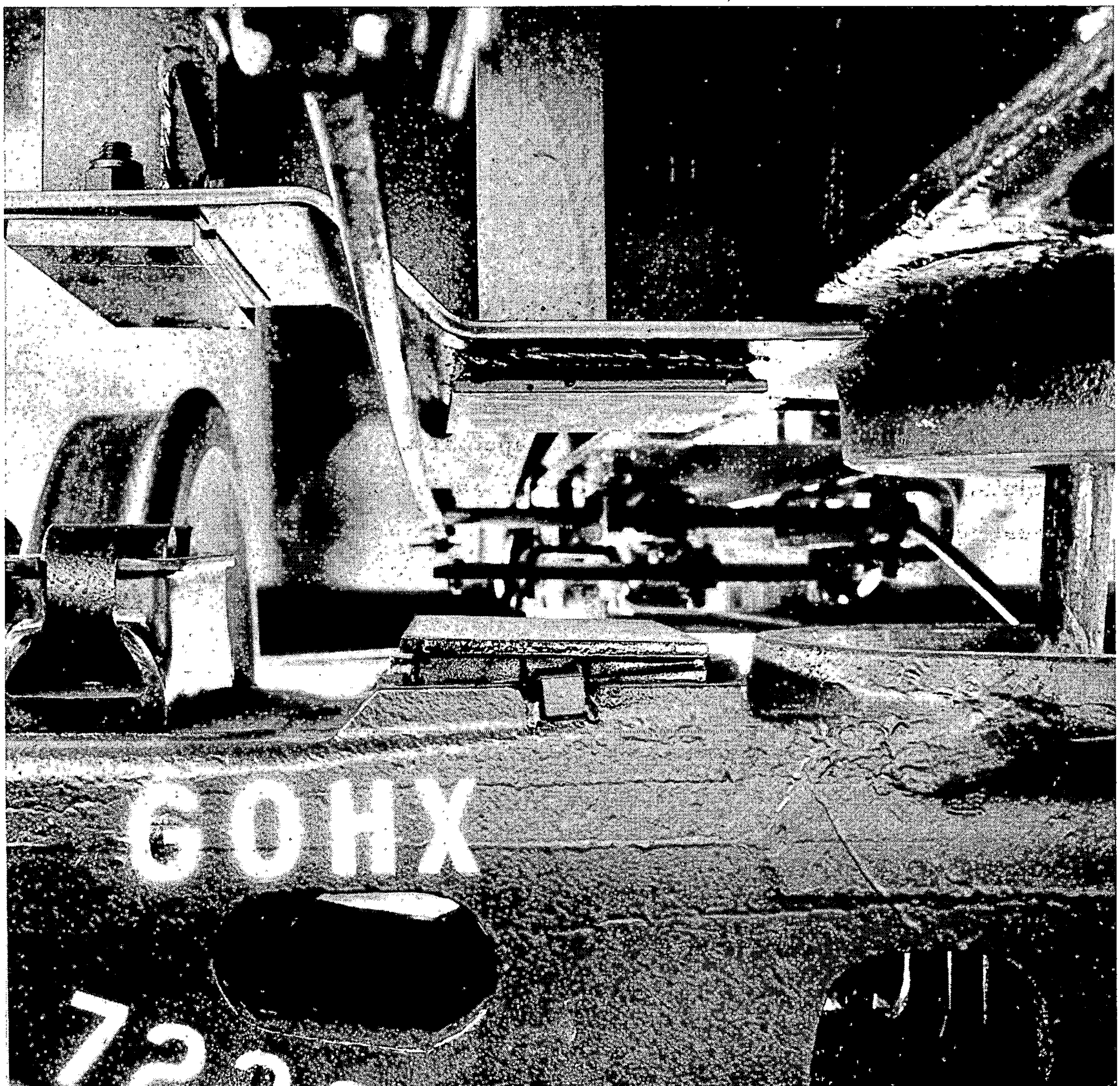


FIGURE 13-1
C-PEP PADS - ARRANGEMENT

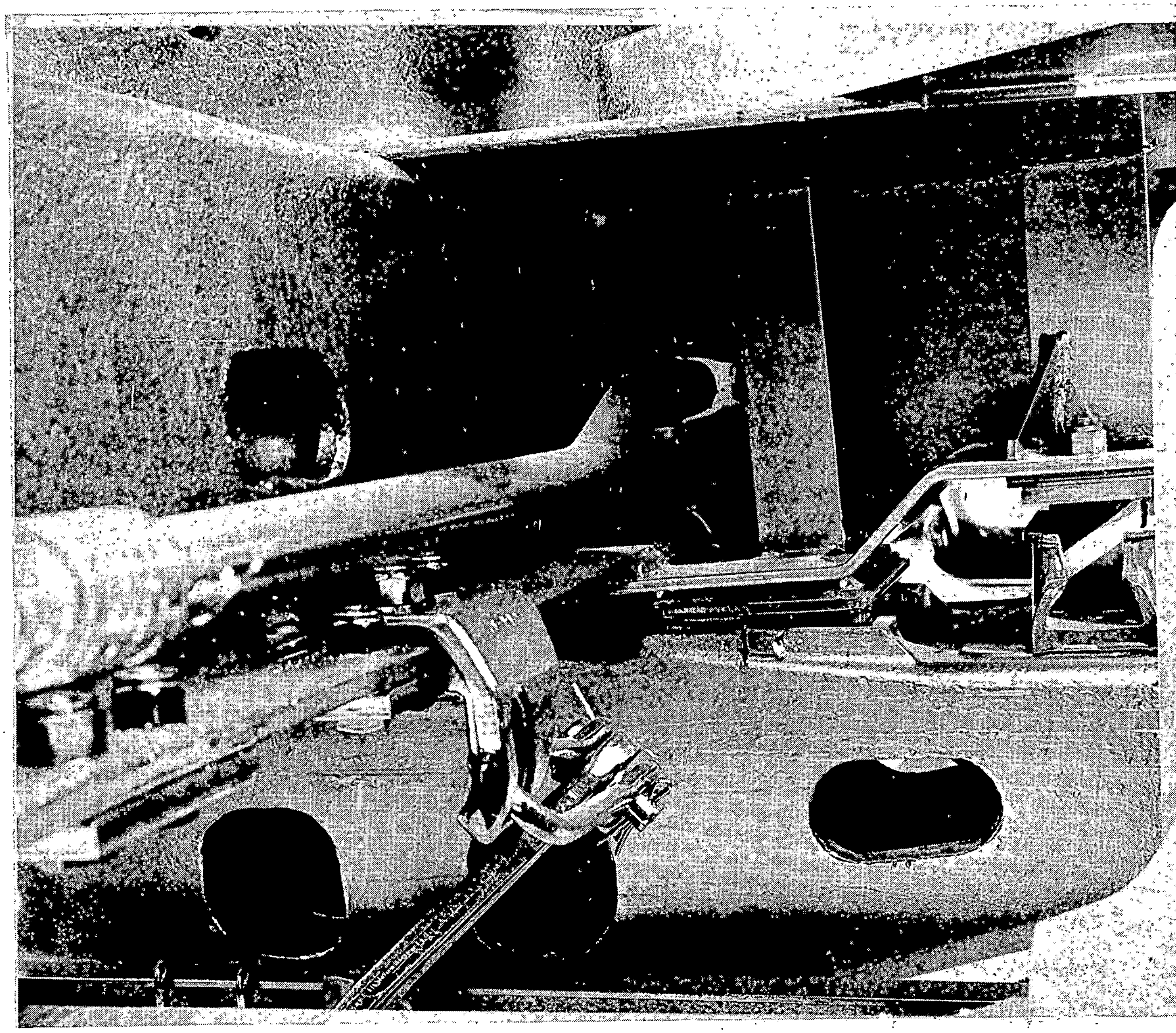


FIGURE 13-2
C-PEP PADS - IN PLACE

Section 14

AUSTRALIAN - 2CM TRUCK

14.1 TECHNICAL

This truck was developed by the Australian Public Transport Commission to meet conditions of track and terrain existing on the Australian Railway System. It was coded by the commission (and is now known) as the 2CM truck.

A low-level version of the design was later produced and coded 2CN. This truck is similar to the 2CM, but has smaller wheels and lower center plate height.

Specifications indicate capacity of the bogie to be "Load Limit at Rail - 38.2 tonne."

Prior to introduction of the 2CM truck, the conventional three-piece truck was used exclusively in Australia. It is still being used on most of their equipment and is operated up to speeds of 60 mph. They report extensive damage to goods in transit, to the track and to the vehicle. Also, they have experienced a high incidence of derailments and severe wear on truck components. The 2CM truck was development to overcome these problems. An assembled 2CM truck is shown in Figure 14-1 and the truck arrangement is illustrated in Figure 14-2.

The truck is made up of a one-piece, rigid-steel frame, consisting of two cast-steel side frames and two cast transoms welded together. The welded joints between transoms and side frames are located adjacent to the side frames. A conventional truck bolster and center plate complete the arrangement.

The truck has dual suspension with both primary and secondary springs. The primary springs are arranged for a dual rate and the secondary springs are single rate.

The 2CM truck has a 14-inch-diameter center plate, 2-1/2 inches deep, and the 2CN has a 24-inch-diameter center plate.

They use spring-loaded side bearings to provide an additional degree of rotational resistance necessary to prevent unstable hunting.

Braking is conventional, using inside, hanger-mounted brake beams.

14.2 FEASIBILITY

The design goals were to produce a truck that would have a derailment factor of safety equal to their passenger car trucks, materially reduce impact loads on tracks, provide an acceptable ride up to 80 mph, and require a minimum of maintenance.

Physical tests were conducted on the side frames and bolsters and they met our AAR requirements for freight car truck components. The complete frame structure was fatigue tested to 25 million cycles to simulate one year's service under extreme conditions.

Ride tests were conducted over a variety of track conditions at speeds in excess of 80 mph, with varying load conditions between empty and loaded, and the number of damaging impact forces between the wheel and track, when compared to a conventional three-piece truck under a similar car, was reduced by 91.7 percent in the vertical direction and 88.4 percent in the lateral direction, when tested at 60 mph, according to the commission's figures.

Test results and service experience to date indicate that the design is entirely feasible.

14.3 SERVICE EXPERIENCE

There are approximately 1,300 car sets of 2CM trucks in service on the Australian railroads with 2,350 on order. The first vehicles equipped with 2CM trucks have now completed 200,000 miles and the wheels have good profiles at this mileage. No problems have shown up in service and the Public Transport Commission considers that all design requirements have been achieved.

There are 200 car sets of 2CN trucks on order, but no reports on service experience are, as yet, available.

14.4 AVAILABILITY

A major manufacturer of the 2CM truck in Australia is Vickers Ruwolt of Vickers Australia Ltd. in Waterloo, NSW, Australia. The truck is also manufactured in quantity by Comsteel (Commonwealth Steel Company Ltd.) of Waratah, Australia, and marketed under the name of their "Fast Freight 80" truck. Trucks for test purposes would be available from either of these companies. There is nothing about the design that would preclude its being manufactured in the United States and a licensing arrangement could be consummated with the Australian Public Transport Commission.

14.5 COST FACTORS

Manufacturers advise that "first cost" of the 2CM design is approximately 50 percent higher than conventional three-piece trucks. Cost figures on the 2CN version are not available.

Their design criteria was aimed at 500,000 miles between truck overhauls and 200,000 miles between wheel turnings, but as the first cars have now completed 200,000 miles with wheels still having good profiles, it would appear that this criteria will be exceeded. The Australians are convinced that maintenance costs will be materially reduced, but are not prepared to furnish quantitative information in this regard.

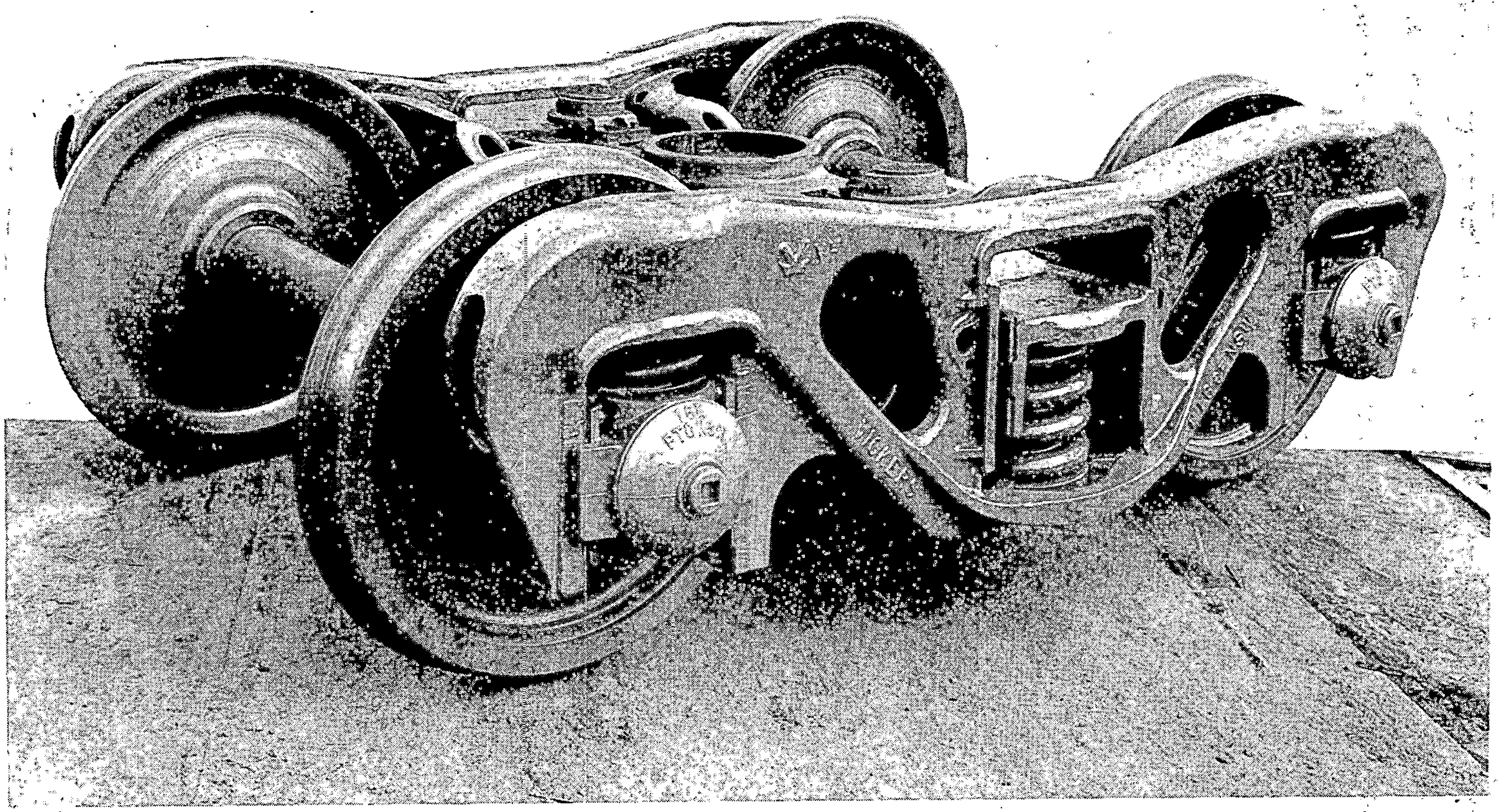


FIGURE 14-1

AUSTRALIAN 2 CM TRUCK

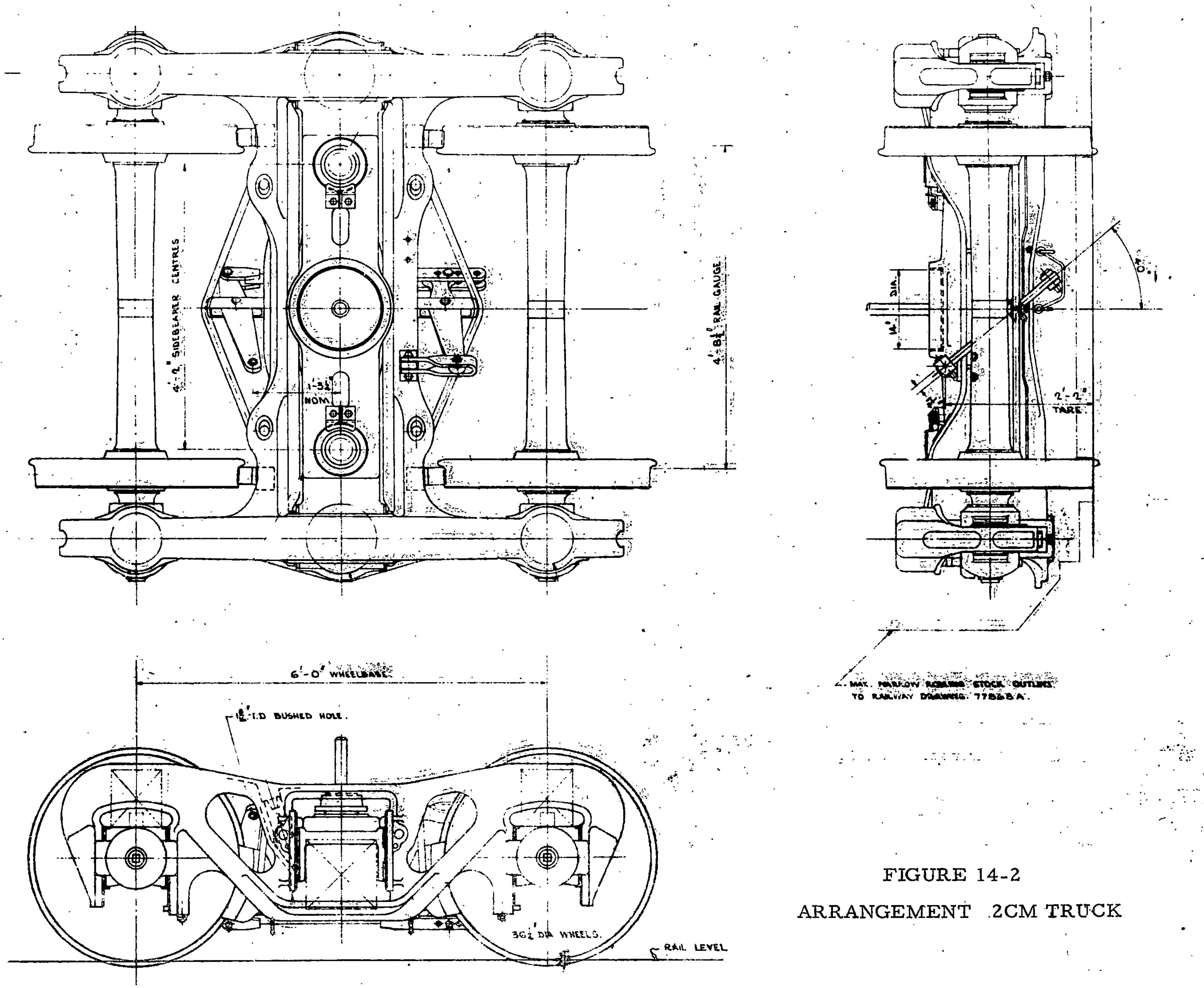


FIGURE 14-2

ARRANGEMENT 2CM TRUCK

Section 15

ROCKWELL EXPRESS TRUCK

15.1 TECHNICAL

The Rockwell Express Truck is a three-piece truck made up of two cast-steel side frames and a truck bolster arranged in a conventional manner. Its major feature is that it has two inboard transoms cast integral with the side frames having spherical connecting bearings located diagonally in the transoms. When these transoms are connected together by the bearings, the truck is held accurately in tram. Truck arrangement is shown in Figure 15-1 and 15-2.

The truck frame acts as a one-piece rigid frame in the horizontal plane but the spherical bearing arrangement allows the two side frames to rotate with respect to each other around an axis through a center line between the two connecting bearings. This allows each individual journal housing to displace vertically when the wheels encounter vertical misalignment in the rail. The transom and bearing are shown in Figure 15-3.

Rockwell claims both a primary and secondary suspension for this design. The "primary" suspension is between the journal bearings and truck frame and consists of elastomer sleeves mounted around the journal bearings. The sleeves are designed to provide a measure of vertical cushioning as well as lateral motion with a restoring force produced by reaction of the elastomer sleeve in shear. The secondary suspension is the coil springs between the truck bolster and side frames and provides the main cushioning for the car.

The truck has friction damping, using a spring loaded composition friction shoe working against one side of the bolster and located diagonally. The truck brake rigging is conventional, using unit type brake beams but package brakes such as Wabcopac and disc brakes have been accommodated in specific applications.

The manufacturer makes the following claims for this design:

- Accurate tram of axle parallelism in service
- Stable performance at high speed operation
- Cushioning of both vertical and lateral high-frequency shocks close to the rail-wheel contact point
- Cushioning of vertical, lower-frequency loads in the secondary suspension
- Friction damping of both vertical and lateral displacements at the secondary suspension
- Equalization of wheel loads
- Few wearing points for low maintenance
- Ease of assembly and disassembly

15.2 FEASIBILITY

Tests were run by the C&O-B&O in 1970 which compared ride qualities of several design premium trucks. Their report on the Rockwell truck indicated that the vertical and lateral car body vibrational power transmitted by the Rockwell truck is substantially reduced from conventional truck design levels of vibrational powers in both the forcing and car body bending mode frequency ranges. The transmissibility of both vertical and lateral high-frequency vibration was reduced approximately 20 percent by use of the elastomer pads at the journals.

The Pacific Fruit Express Co. applied three car sets in May of 1966 for a comparison of various design premium trucks. Observations of the trucks in service indicated that wheel flange wear was reduced materially, indicating a stable performance.

In 1971, a joint SP-UP-PFE ride test was conducted on the various premium trucks. Report on the Rockwell design indicated that unstable hunting was controlled. Lateral shocks were materially reduced but vertical control was not considered adequate.

All tests indicated the trucks to be stable laterally and safe to operate in general service. The design is considered entirely feasible.

15.3 SERVICE EXPERIENCE

The first application of a Rockwell Express truck was made to a KCS caboose in March 1964. These trucks have been in steady service since that time and performing in a satisfactory fashion. The following railroads have used or tested the truck on head end, caboose, unit train, and specialized freight service: KCS, Santa Fe, L&N, BN, C&O-B&O, Missouri-Kansas-Texas, RI, St. Louis-San Francisco, Penn Central, Canadian National, MoPac, P&LE, Southern and Trailer Train. Since 1964, there have been 164 car sets placed in regular service or applied for test.

The three car sets applied by the PFE for test are still in service and each has now accumulated approximately 350,000 miles. These trucks can be made available for examination.

15.4 AVAILABILITY

The trucks have been supplied in the past by the Transportation Equipment Division of Rockwell International, Atchison, Kansas; however, this design is no longer in production by Rockwell because the considerable premium price could not be justified by the railroads that were considering improved trucks. Patterns are no longer available but the truck could probably be furnished should sufficient demand develop to justify production. Test trucks could be furnished by PFE or others.

15.5 COST FACTORS

First cost of the Rockwell truck is approximately double that of conventional design. Casting the transoms integral with the side frames, machining the journal and transom bearing surfaces and providing spherical connecting bearings mandate a high cost.

Maintenance costs are materially reduced due to less wheel wear as well as less bolster to side frame and center plate wear. Service experience has shown that no serious maintenance problem has developed to date.

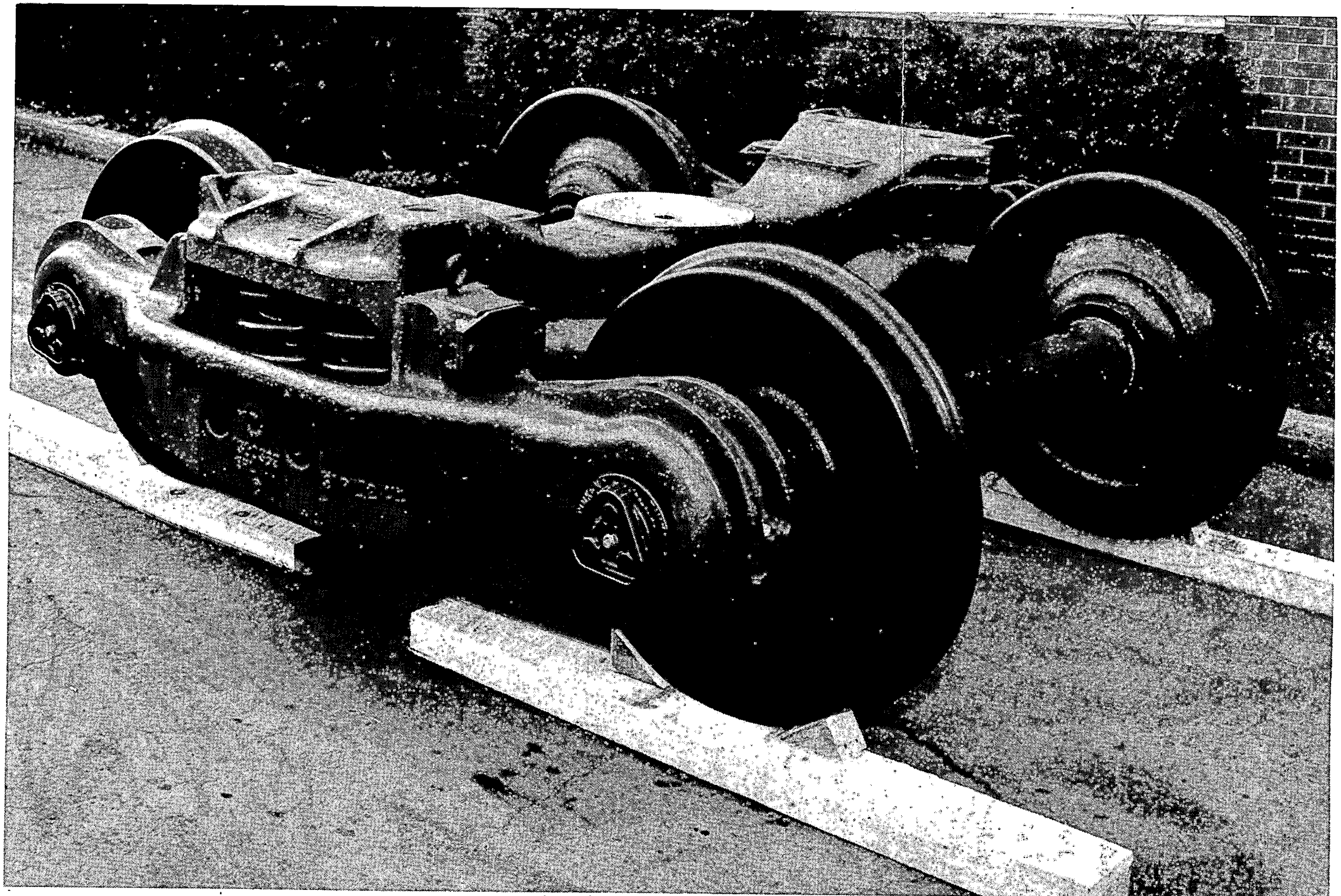
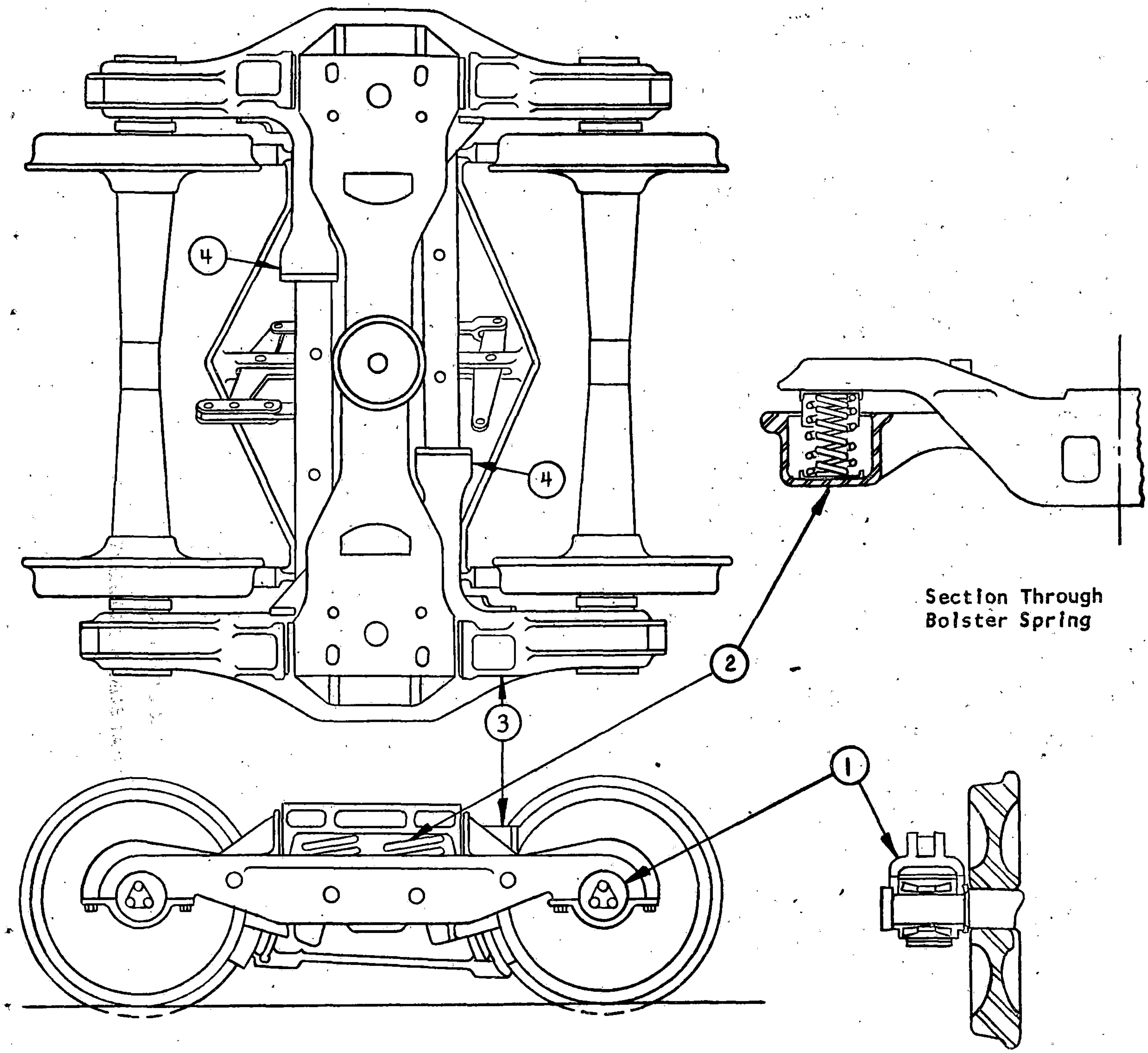


FIGURE 15-1
ROCKWELL TRUCK



1. Journal Suspension With Rubber Sleeve
2. Secondary Suspension
3. Snubber Arrangement
4. Spherical Bearing Housing

FIGURE 15-2

ARRANGEMENT - ROCKWELL

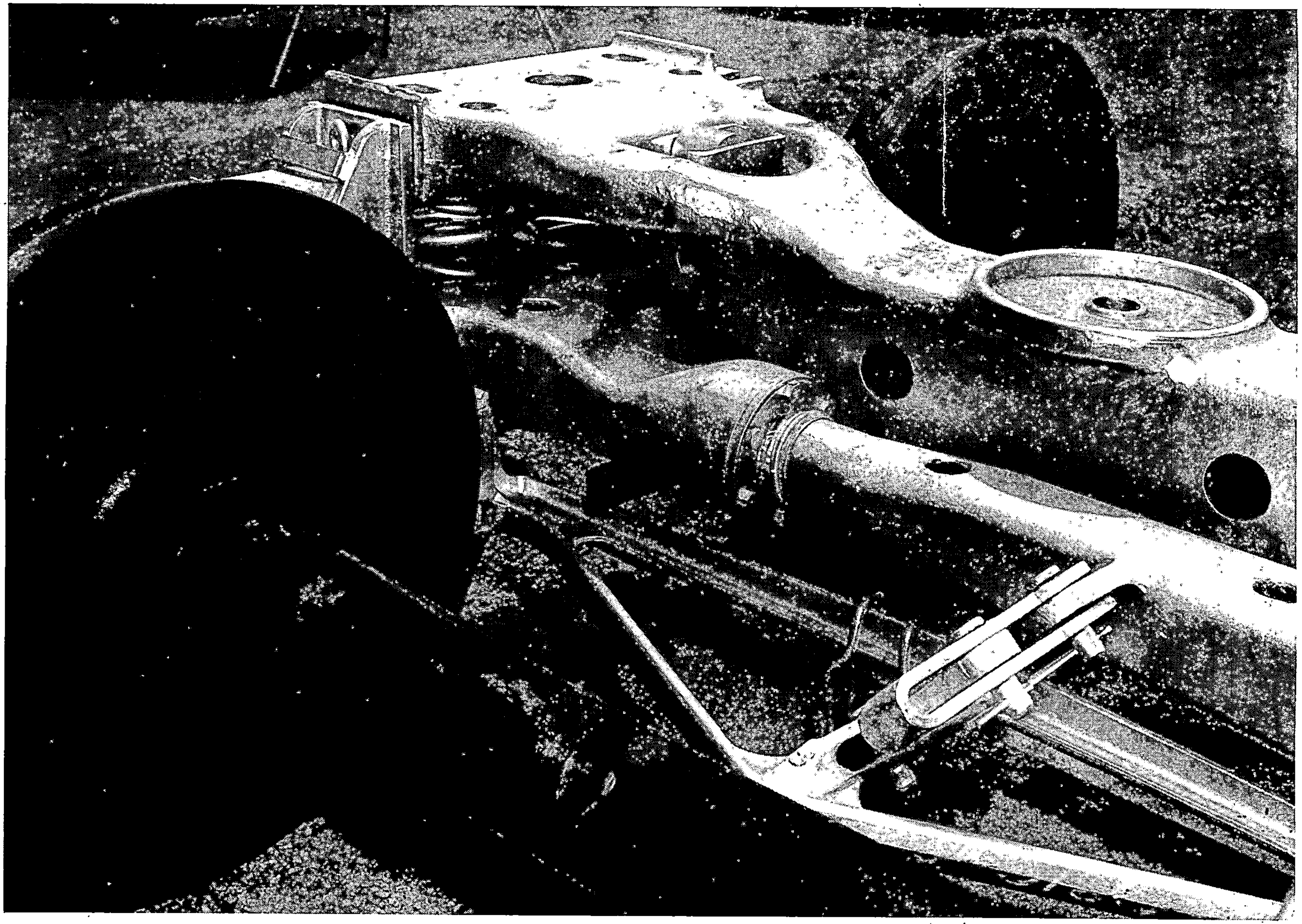


FIGURE 15-3

TRANSOM & BEARING

Section 16

RAILMAC TRUCK

16.1 TECHNICAL

The Railmac truck is a design developed by the R. W. Mac Company of Crete, Illinois. It consists of "lateral absorbing springs" placed at an angle between the truck bolster and side frames together with "equalizer arms" that connect the two side frames together (as well as provide support for the spring seat of the lateral springs). As additional features, they propose using replaceable gibs on the truck bolster and "wrap-around" column wear plates on the side frames. "Type 1" design utilizes lateral absorbing springs placed on an angle and "Type 2" places the extra springs in a vertical position for added load-carrying springs only. General arrangement of the Type 1 is shown in Figure 16-1 and Type 2 in Figure 16-2.

The device is intended for application to existing trucks by adding the special parts and to new trucks by having the spring seats and equalizer pockets cast integrally. All other parts of the truck are conventional. Figure 16-3 shows the Railmac parts assembled in the Type 1 configuration and Figure 16-4 gives an exploded view of all the parts. They also propose an additional support to the truck bolster consisting of double tie rods on the underside. These are shown in Figures 16-1 and 16-2.

It is intended that the combination lateral-absorbing and load-carrying springs placed on an angle to the horizontal plane will provide a resistance and restoring force to lateral motion. The equalizer arms are to provide resistance and a restoring force to longitudinal movement of the side frames and, at the same time, allow rotation in relation to each other.

Use of the replaceable (and reversable) gibs on the truck bolster is expected to reduce maintenance cost by eliminating the need to restore gibs by welding and provide a quick, easy method of restoring gib clearance by replacing, or reversing, the gib shoes. This is accomplished by driving out the spring steel locking key from the holder and reversing (or replacing) the shoe. These shoes can be reversed, or replaced, on a repair track without dismantling the truck. The "wrap-around" column wear plates provide the other half of a replaceable wearing surface at the contact point of the bolster gibs (as well as the contact surface for the bolster control wedge). The wrap-around wear plates can only be applied to side frames with pockets cast integrally and cannot be applied to existing frames.

The designer makes the following claims for the device:

- Retrofit applications can be made in railroad shops and can be fitted to most designs of AAR-approved trucks.
- Angular added springing arrangement of Type 1 will provide a measure of controlled lateral motion.
- Allows use of softer, lower rate springs to reduce rough riding problems.
- Truck equalizer arms will stabilize the truck and minimize unstable hunting as well as improve "curving ability." A leaf spring loaded, constant-contact side bearing (as shown in Figure 16-2) is also available for further control of unstable hunting.

- Replaceable bolster gibs and "wrap-around" wear plates will materially reduce truck maintenance costs.
- Truck bolster supports can be added to truck bolster designs that are prone to failure.

16.2 FEASIBILITY

A prototype truck has not been assembled and projected performance is based on calculations and observations of a scale model. These observations would indicate that the concept is probably feasible.

16.3 SERVICE EXPERIENCE

There has been no service experience with the complete truck concept; however, there have been 525 car sets of the truck bolster supports applied and the manufacturer is in the process of applying 20 car sets of the replacement bolster gibs for test purposes. No reports on these applications are yet available.

16.4 AVAILABILITY

The device would be available from the R. W. Mac Company. The company has indicated that they will supply all parts and hardware for application to one car set of test trucks and will supervise the installation. Other truck parts would be available from regular suppliers.

16.5 COST FACTORS

Total cost for material and labor of the retrofit application to existing trucks is estimated at approximately $1,200 per car set. Cost of adding the system to new trucks would be about $750.

No figures are available on maintenance costs; however, should design goals be achieved, a significant reduction in overall maintenance should be expected.

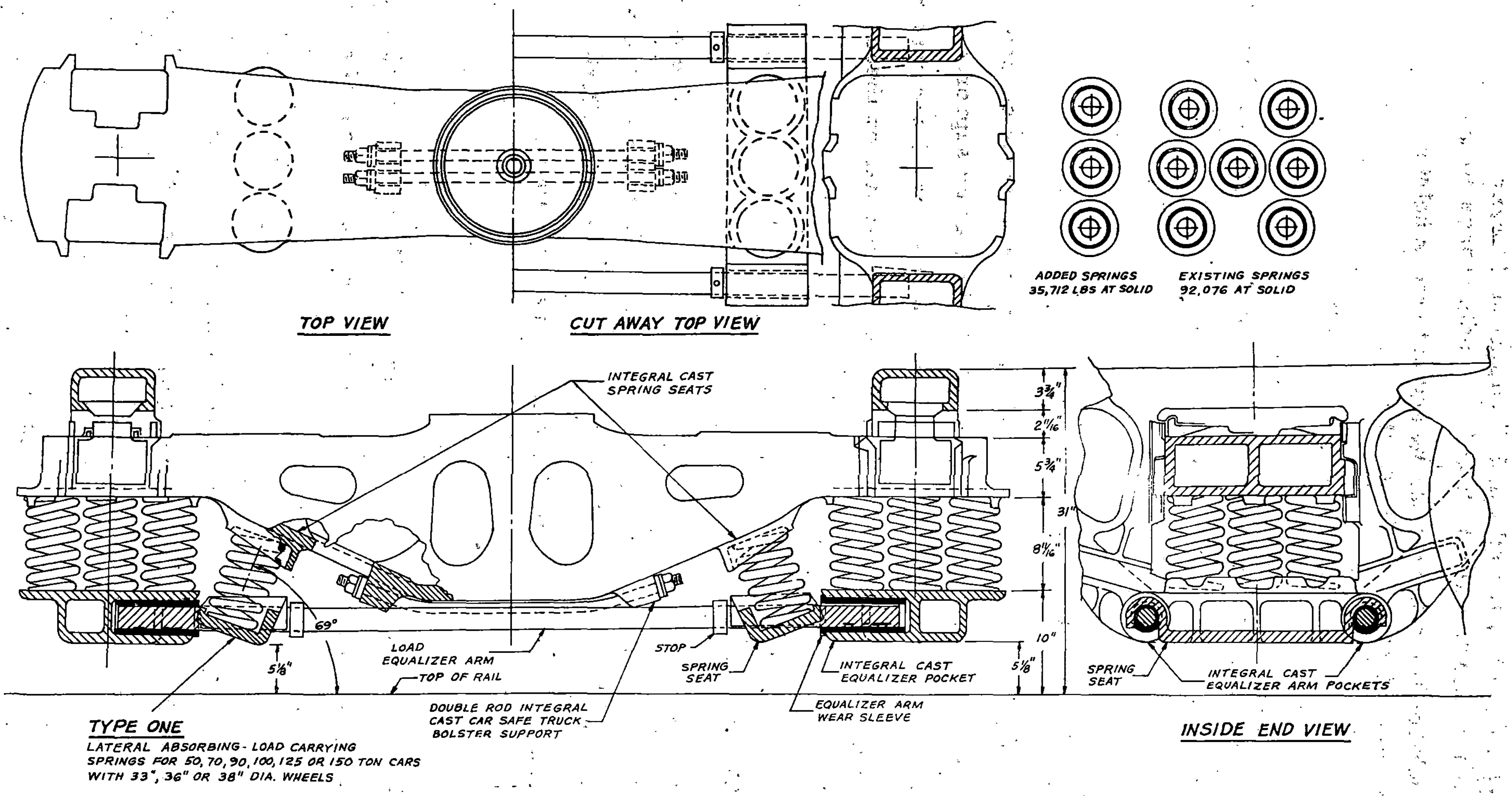


FIGURE 16-1

RAILMAC TRUCK ARRANGEMENT - TYPE I

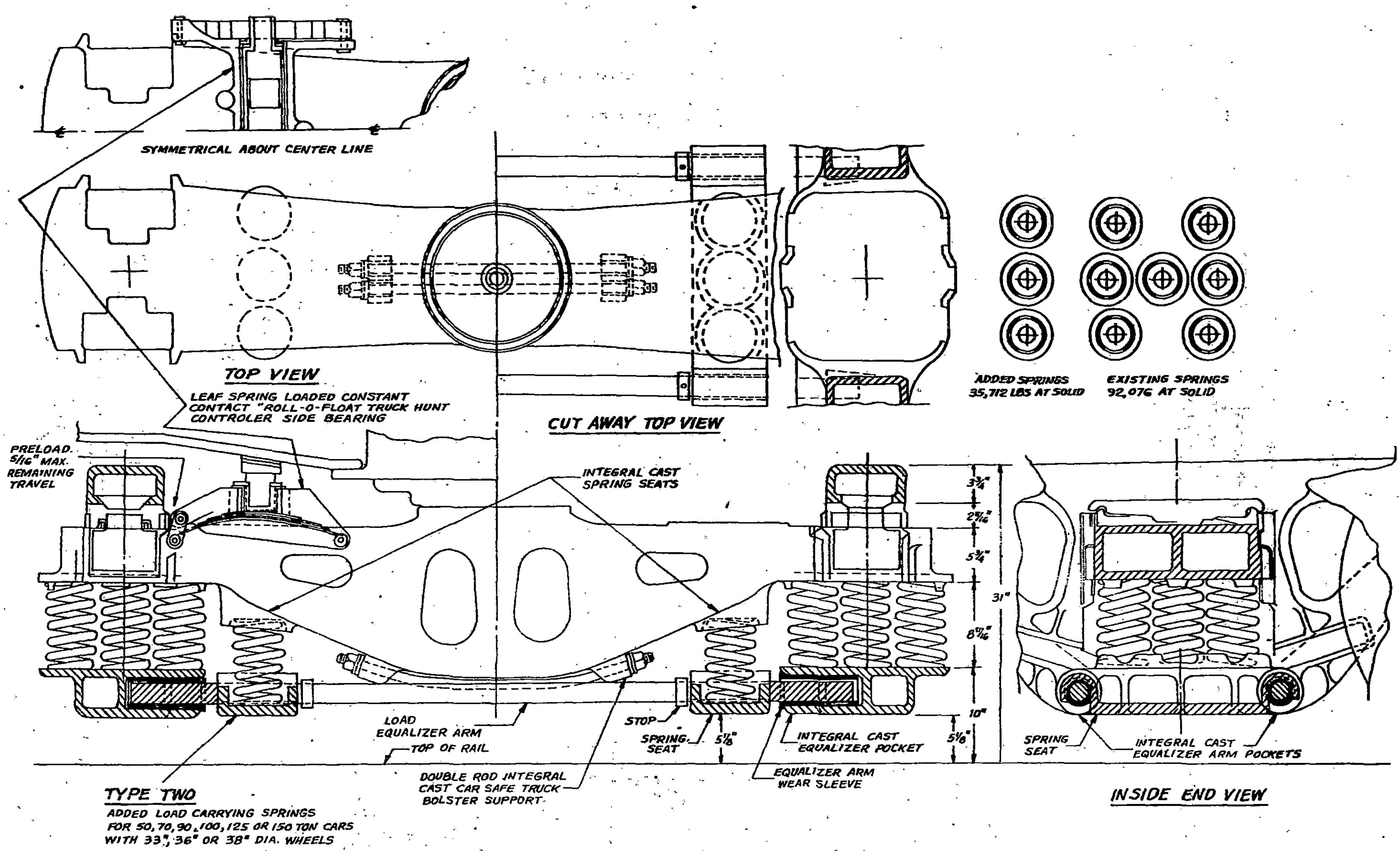


FIGURE 16-2

RAILMAC TRUCK ARRANGEMENT - TYPE II

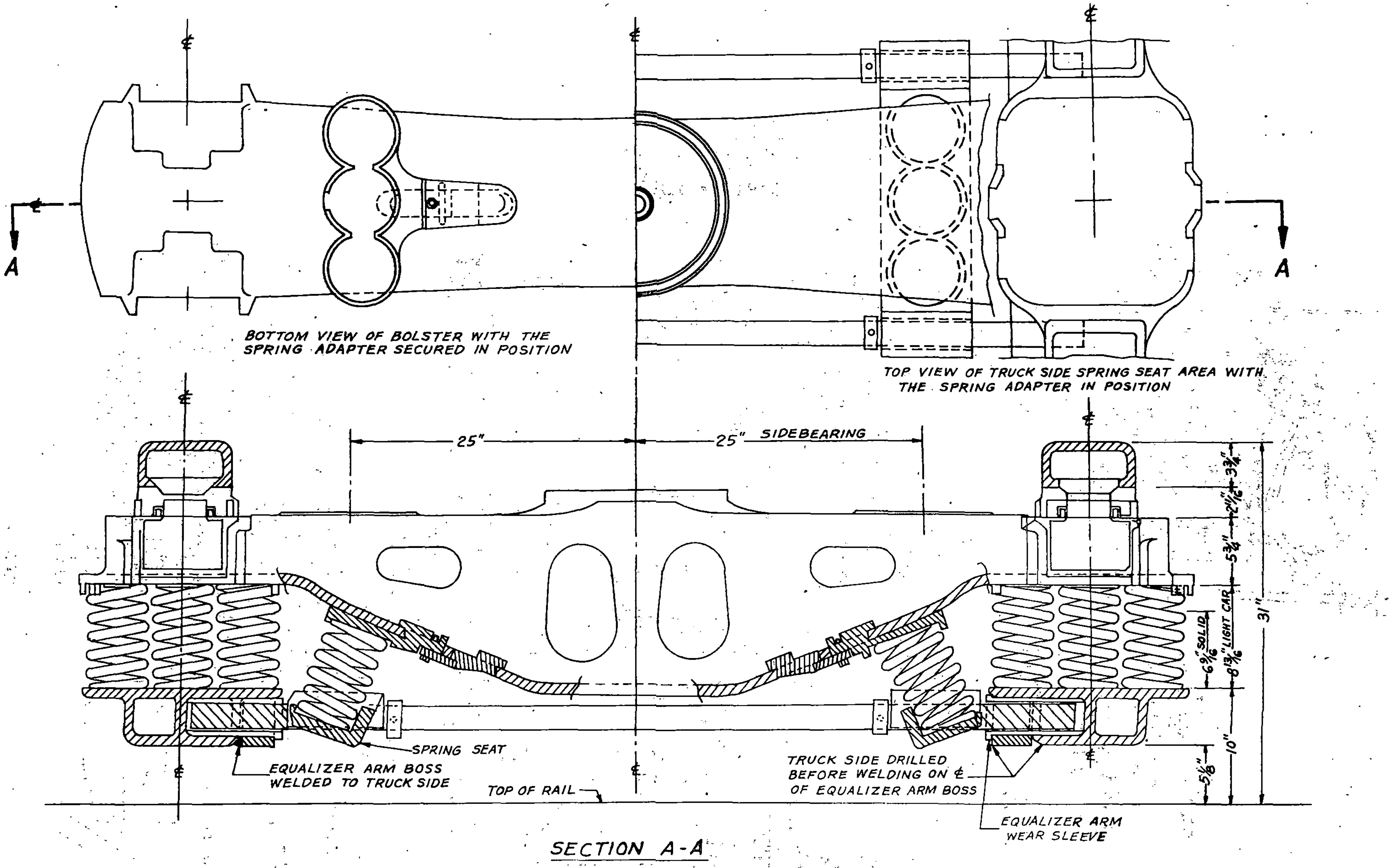
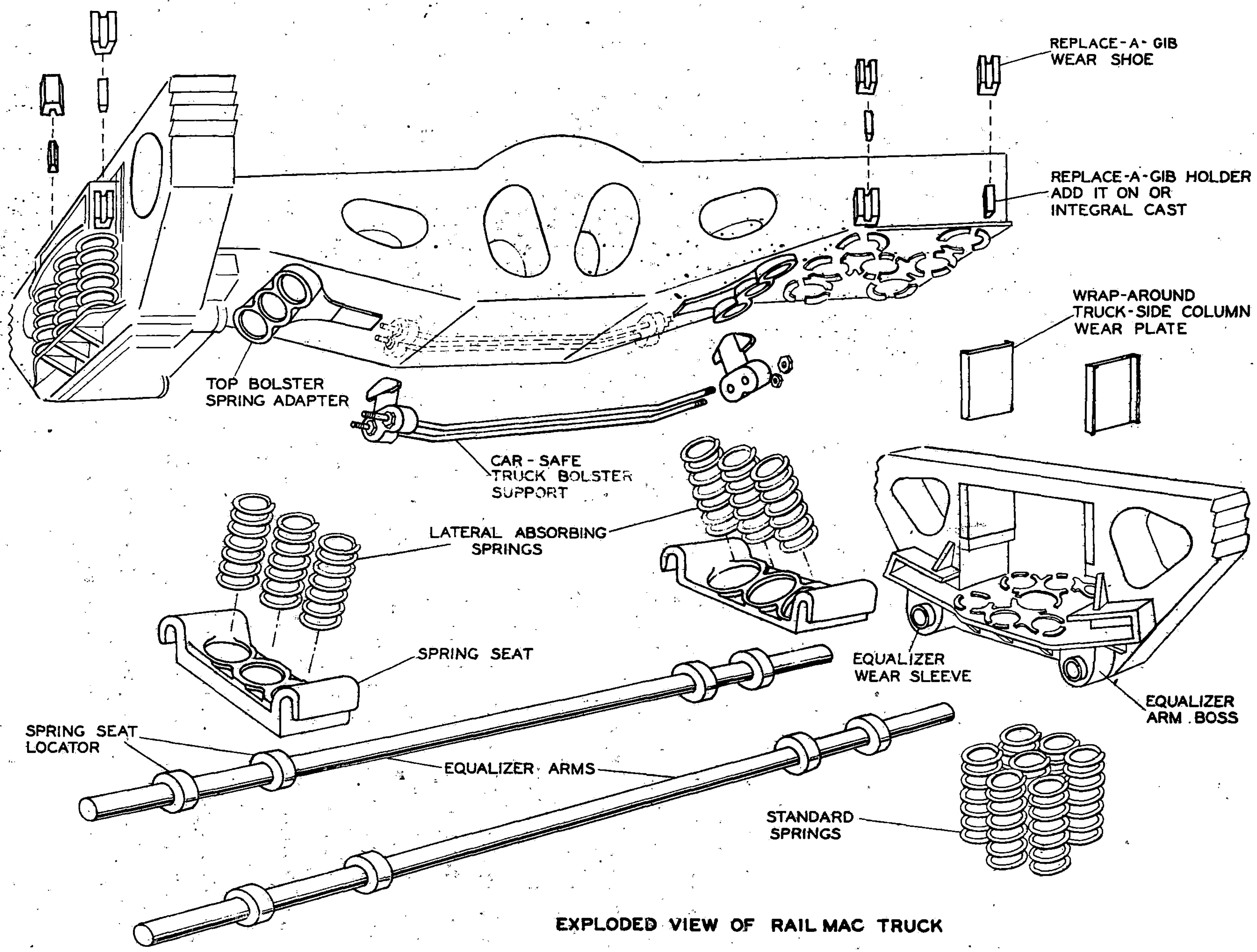


FIGURE 16-3

TRUCK RETROFIT KIT



EXPLODED VIEW OF RAIL MAC TRUCK

FIGURE 16-4

PARTS ARRANGEMENT

Section 17

ALUSUISSE TRUCK

17.1 TECHNICAL

This truck was developed by Alusuisse Aluminum of Swiss Aluminum Ltd., Zurich, Switzerland. The development was first conceived for use by the Rhaetian Railway of Switzerland in a one-meter gauge version. This railroad operates through a very mountainous region with long, steep grades and extreme hazards of climate, including ground undulations due to freezing, ice formation and heavy snowfalls. The railroad has heavy traffic of petroleum products in tank cars. They consider that when relatively long tank cars with high rigidity are used on mountain tracks with many sharp curves and frequent track unevenness due to ground undulations, precautions must be taken to ensure that sudden and undue removal of wheel load does not result in a derailment.

The Swiss designers concluded that because the car could not be readily designed with what they considered the necessary degree of "suppleness," then the bogie itself had to be sufficiently supple. The Alusuisse design has no side frame in the accepted sense and meets this pliability requirement to a large extent.

The truck consists of two swing arms pivotally attached to the ends of a truck bolster and supported by dual leaf springs, providing a "scissor" action.

This arrangement of a one-meter gauge design is illustrated in Figure 17-1. A model of the design in standard gauge has an extended frame for support of an outside brake beam to form a clasp brake arrangement as shown in Figure 17-2. Major parts of the truck are made of aluminum to accomplish significant weight reduction. The aluminum bolster and swing arms are shown in Figure 17-3.

A dual rate spring arrangement is obtained by one spring supporting the car when empty or lightly loaded, with the other making contact at the ends as the car is loaded. This arrangement is seen more clearly in Figure 17-4.

The truck is center pivotal, utilizing a conventional European-type, dished center plate. It also has constant-contact friction side bearings located outboard approximately on line with the wheel treads. A safety cable is provided to prevent collapse of the scissor arrangement in case of a broken spring.

The pivotal arrangement of the side frame wings allows independent vertical movement of each wheel to conform to vertical irregularities in the track. The two swing arms at each pair of wheels are linked together by a spring rod which forms a prolongation of the journals of the two swing arms.

An interesting characteristic of these trucks is the tendency of the truck wheel base to increase with increasing load. Because wheels on the outside rail of curves are usually more heavily loaded than on the inside rails the wheel sets undergo a self-adjusting movement which allows the axles to seek a more radial position.

17.2 FEASIBILITY

Extensive tests were made in 1973 with an empty and loaded tank car on the "Bernina" line which has very severe curvature and grade conditions. The trucks were fitted with strain gauges and accelerometers to analyze all parts of the truck. Their evaluation of the data confirmed a good correlation between actual and calculated stresses. As a result of their extensive testing, Swiss engineers have projected a life of 40 years for the aluminum components and they consider the running characteristics to be "very good" when compared to conventional European designs.

Trucks of the same design but of standard gauge were tested in 1971 at speeds up to 120 km/hr and some difficulties were encountered, particularly with the brake equipment. These tests were on the clasp brake type (Fig. 17-2) and reaction moments of the eight-shoe brake system resulted in undesirable pitching oscillations of the bolster. Road tests have been resumed, after modifications, at speeds up to 140 km/hr but results are not yet available.

17.3 SERVICE EXPERIENCE

The truck has been manufactured in small quantities and used on a limited scale on the Swiss Federal Railways. The Swiss Railway system is now operating 11 tank cars with one-meter gauge Alusuisse trucks. One car has been in service since 1969 and the others since 1973.

17.4 AVAILABILITY

This truck has been manufactured exclusively by Swiss Aluminum Ltd. of Zurich; however, there is nothing about the design that would preclude its being manufactured in the United States and a licensing arrangement could, no doubt, be arranged.

17.5 COST FACTORS

No cost figures are as yet available; however, by nature of the design (which includes considerable machining, double leaf springs, a multiplicity of parts, etc.), it would appear that first cost would be greater than conventional trucks. Manufacturers, however, expect the cost to be comparable to conventional European-design trucks.

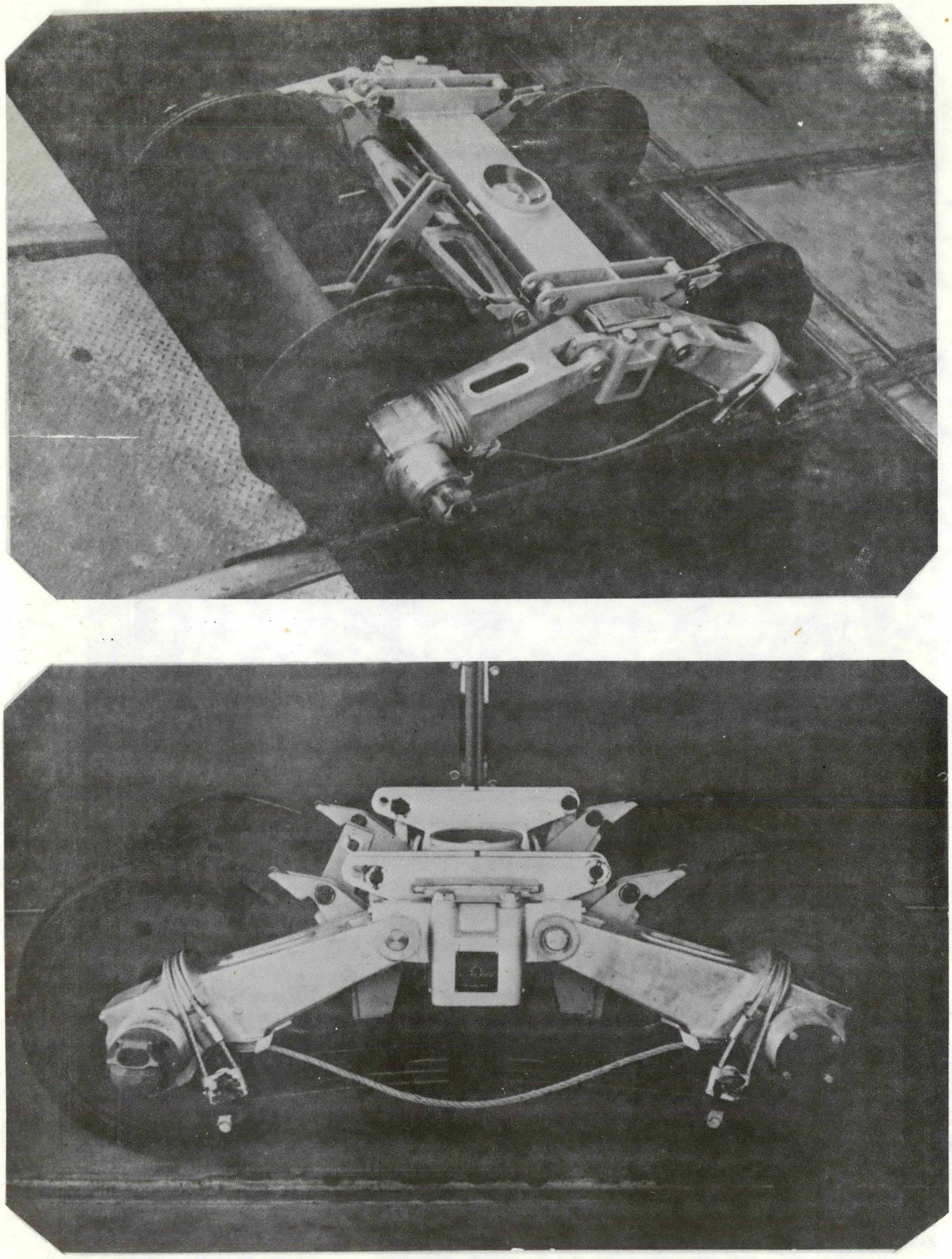


FIGURE 17-1

ALUSUISSE ALUMINUM TRUCK

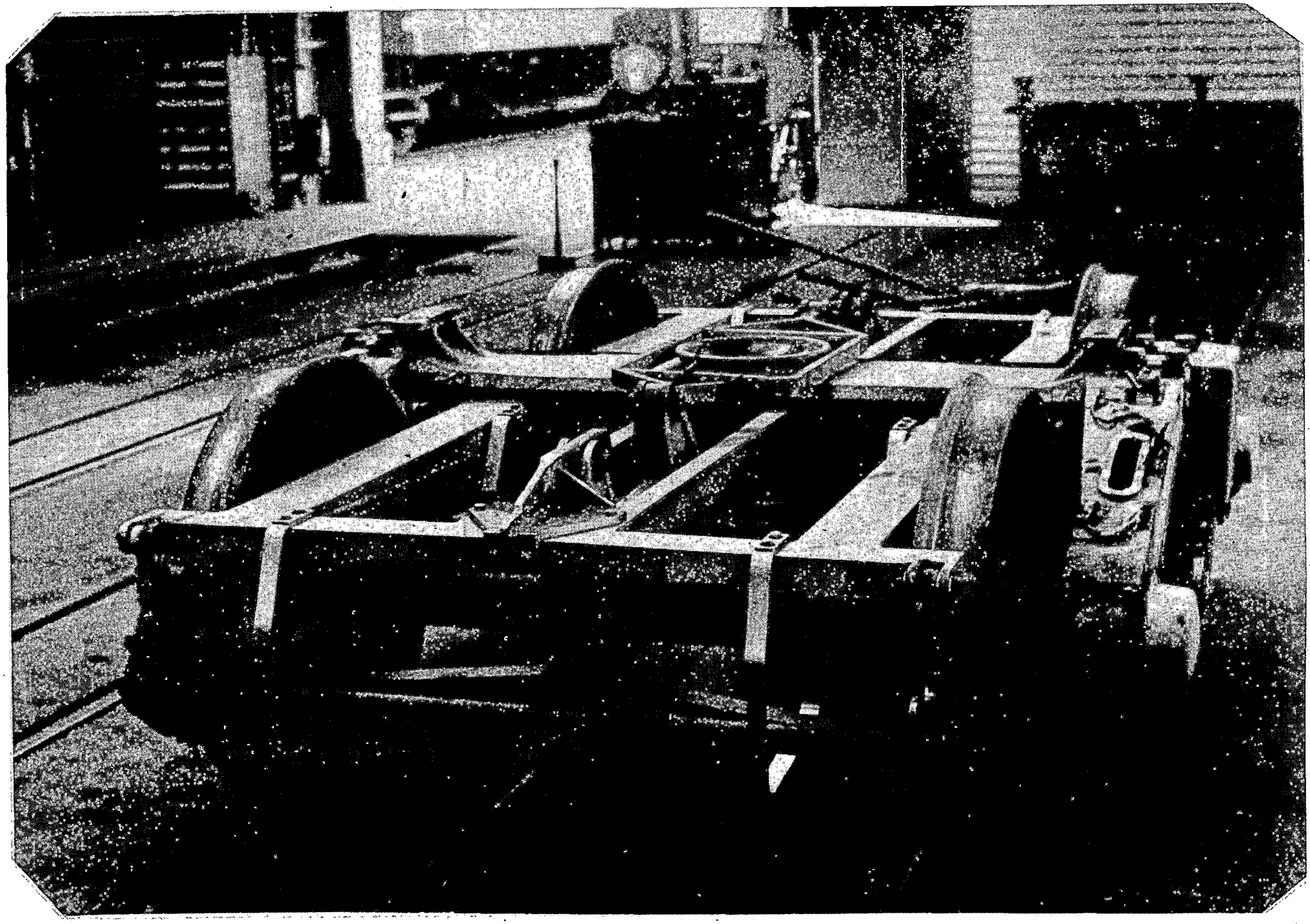
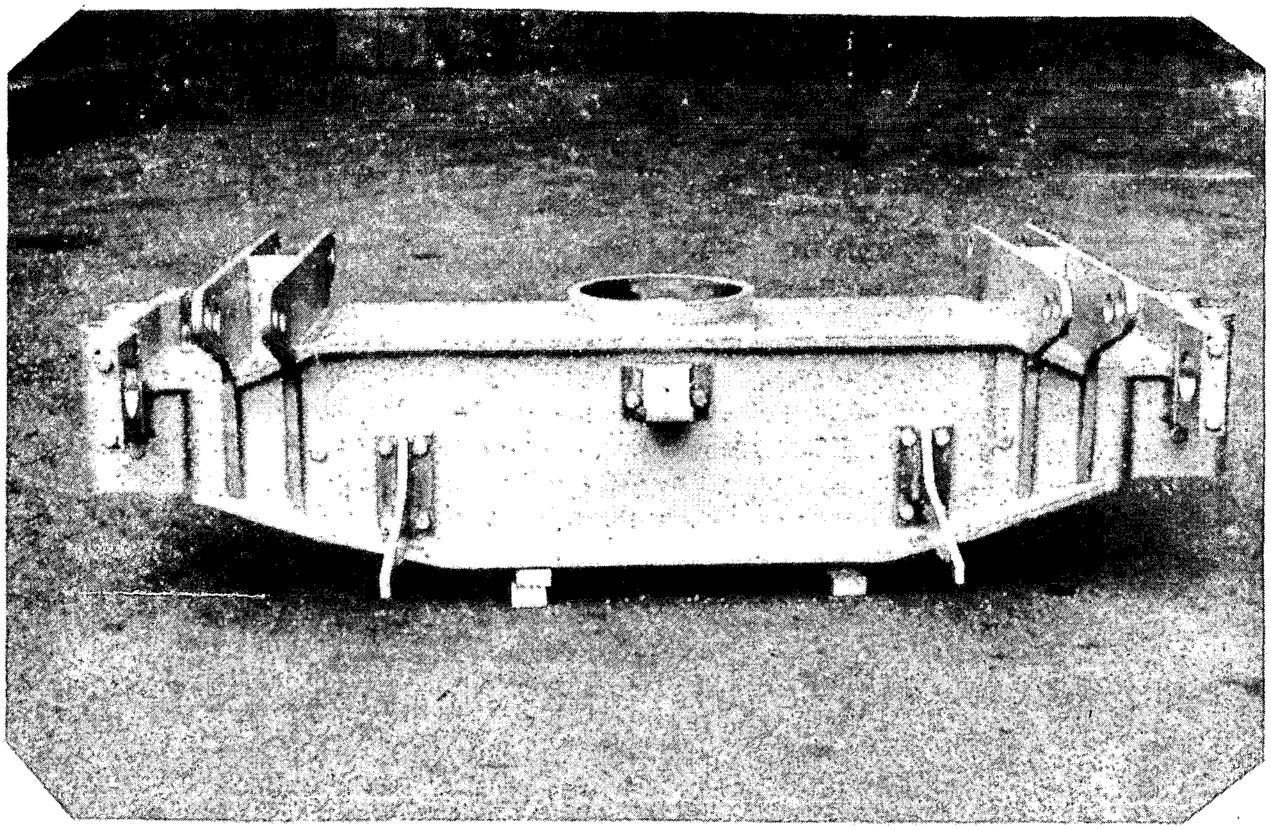


FIGURE 17-2

TRUCK ARRANGEMENT - CLASP BRAKES



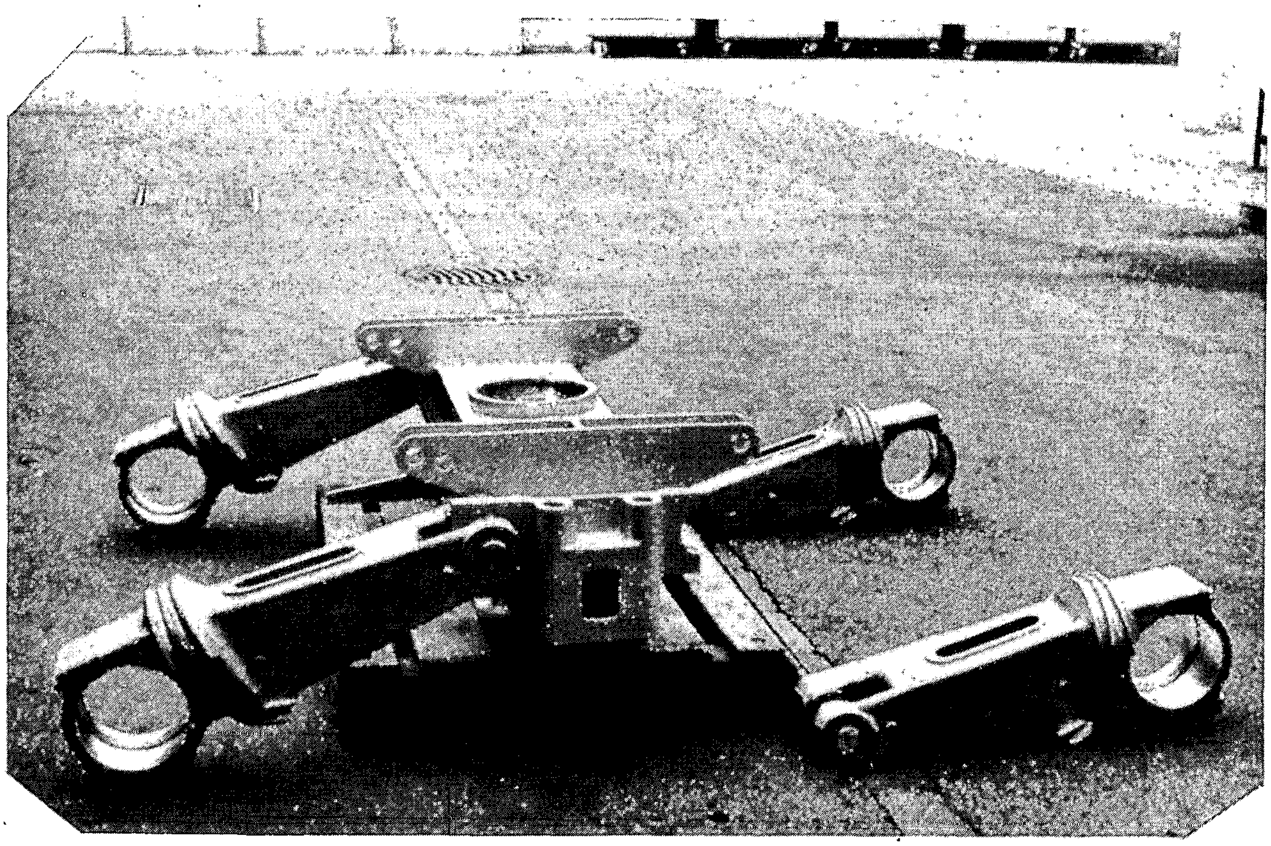


FIGURE 17-3

ALUMINUM TRUCK PARTS

Section 18

LIST TRUCK

18.1 TECHNICAL

This system, developed by Mr. H. A. List of Railway Associates, Inc., is a "steering device" which consists of parts that tie the axle boxes together in such a manner as to allow the wheel sets to assume a radial position on curves and prevent lozenging on tangent track. An arrangement of this concept is shown in Figure 18-1.

It is planned initially to market a kit to retrofit existing roller bearing trucks for improved performance and reduced maintenance. It is also the intent to offer a similar modification of the standard three-piece truck for new cars.

The mechanism ties together opposite axle boxes, which devices are, in turn, connected through one of the bolster openings as shown in Figure 18-2. An elastomer pad is provided between the roller bearing adapter and roof of the side frame pedestal with adequate clearance longitudinally to allow wheel sets to move in seeking a radial position.

The inventor makes the following claims for the device:

- Improves ride and safety
- Reduces maintenance
- Eliminates unstable hunting up to speeds of 100 mph
- Negotiates curves up to 4 degrees without flange contact and on sharper curves materially reduces angle of attack
- Prevents lozenging of truck framing
- Incorporates improved brake beam alignment to minimize brake shoe flange wear

18.2 FEASIBILITY

Tests have been run on prototypes of the List truck by the Lehigh Valley and Canadian National. Detailed reports on these tests are not available; however, the device operated safely and appears to be feasible.

18.3 SERVICE EXPERIENCE

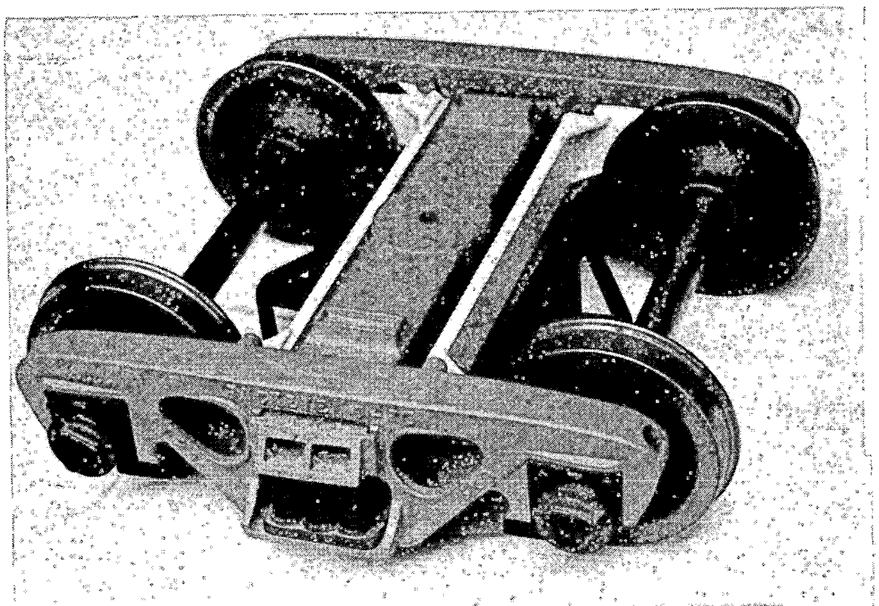
Other than the service involved in the tests referred to in Paragraph 18.2, there has been no service experience on the arrangement.

18.4 AVAILABILITY

There is nothing about the design that would preclude its being manufactured by any competent fabricator and it could be made available. Composition, characteristics, and quality of the elastomer pads would need to be closely controlled.

18.5 COST FACTORS

Precise first cost figures are not yet available. Computer studies and preliminary tests indicate that wheel wear and rail wear will be materially reduced and wear on other truck parts should be less, resulting in reduced maintenance costs. Offsetting costs would be incurred by maintenance of the device and occasional replacement of elastomer pads.



GENERAL ARRANGEMENT VIEW - 1/8 size Model "LIST" TRUCK

FIGURE 18-1

LIST TRUCK

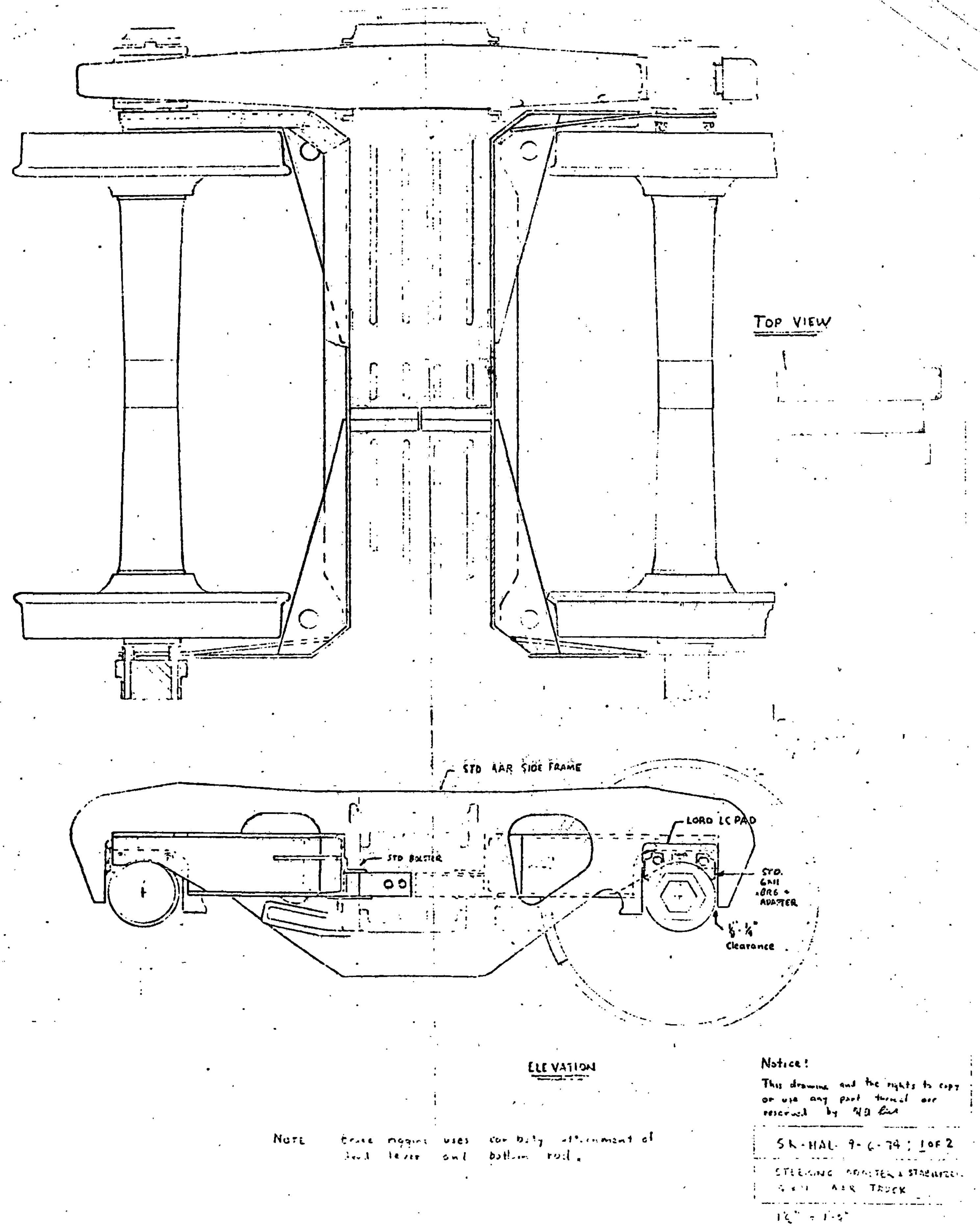


FIGURE 18-2
STEERING ADAPTER & STABILIZER

Section 19

MISCELLANEOUS

19.1 SCOPE

There are several devices suggested by inventors that wish to have their ideas developed but have no backup data or test results. In some cases, detailed information is not available owing to the proprietary nature of their ideas. There are also some trucks that have been developed, but later discontinued by their manufacturers owing to cost or other factors.

It is the purpose of this section to give reference information on these ideas or designs for record purposes and for possible future follow-up.

19.2 H. N. PATTON AND SHCR ASSOCIATES

This is a truck design, developed by Mr. H. N. Patton of Seattle, known as the "Mini-Trux III." The design consists of a rigid frame with primary springing. The major principal of the device is in the use of rod-shaped elastomer springs.

Mr. Patton has referred his idea to Ortner Freight Car Co. of Cincinnati, Ohio for development. Ortner has built one prototype, but due to proprietary nature of the development, further information is not available at this time.

19.3 GENERAL STEEL INDUSTRIES

General Steel developed and produced a premium freight car truck in 1961 known as the GSI Aligned Truck. The major feature is an aligning device, similar to their passenger car trucks, to provide positive alignment. The truck is used by the Union Pacific and others in unit train service and proved to be successful. The UP cars have been in use in a unit train coal movement for about 10 years. There are 150 car sets on the Union Pacific, 240 car sets on the Australian Railways and 387 car sets in service in the Union of South Africa. While a successful design, it was not used extensively because of cost and its manufacture has been discontinued, for the present, by General Steel Industries.

General Steel Industries also has a licensing arrangement with Gloucester Railway Carriage Co. in England to produce an Americanized version of their "Chevron" truck. This design used elastomer springs arranged in a chevron pattern with the intent that the restoring force of the elastomer pads in that configuration would stabilize the truck.

Several prototype trucks were produced and tested. Tests on the Penn Central indicated a satisfactory performance; however, instrumented ride tests run by the Canadian Pacific and Pacific Fruit Express indicated that the device was unstable at high speeds. General Steel's analysis indicated that the problem was in composition of the elastomer pads and furnished new pads for one car set of trucks retained by PFE. The trucks have not been placed in service and are available for further testing, if desired. No additional trucks have been produced.

19.4 GRASCO, INC.

Mr. W. A. Robertson, president of GRASCO, Inc. of Greenwich, Connecticut, has proposed a development project for developing and testing his version of a freight car truck utilizing air springs. GRASCO is a successful supplier of air spring equipped bogies for highway trailers. Mr. Robertson has a finite design in mind for a freight car truck, but is not willing to disclose details without a formal agreement to build and test prototypes.

19.5 RAILWAY PTY., LTD.

Mr. E. A. Clifton of Cheltenham, Australia, has developed a device to stabilize existing trucks that he calls an "Encon Bar." It consists of a leaf spring mounted outboard of the side frame to stabilize the truck in tram as well as provide a measure of controlled lateral motion. He is negotiating with an American company to develop the device and additional information is not available at this time.

19.6 DISPENSERS PTY., LTD.

Mr. J. B. Mackaness of Dispensers Pty., Ltd. in Australia has contacted TDOP by letter indicating that they have a truck development for consideration in Phase II of the project. Due to the proprietary nature of his idea, he is unwilling to disclose detailed information at the present time but will make further contact at a later date.

19.7 E. H. WILLETS

Mr. Elwood H. Willets of Bay Shore, Long Island, has submitted a sketch which portrays his patented approach to a railway suspension system. It consists of an elastomer-cushioned, crossed-lever arrangement designed to hold the truck frame parallel vertically while providing restraint and cushioning. It uses elastomer load springs and elastomer-cushioned hubs at all lever pivot points.

The design provides for pivoting of the truck on a kingpin, but the load is taken directly on a low-friction elastomer side bearing. It utilizes elastomer pads and bushings at all load carrying points to provide "total shock isolation" as covered by Mr. Willets' patent application.

19.8 HYDRAULICS HOUDAIL INDUSTRIES, INC.

Mr. A. G. French of Hydraulics Houdail contacted TDOP, submitting information, including brochures, on the various types of snubbers, (both friction and hydraulic) manufactured by his company together with an offer to work with TDOP when the project begins its study of modifications of existing designs.

This company's line includes many different types of snubbers in a multiplicity of sizes that have been used successfully on various foreign and domestic passenger and rapid-transit cars. The data are on file.

19.9 THREE-BEARING WHEEL SETS

The possible use of wheel sets with one free wheel has been considered and tried from time to time over the years on several railroads. The concept has included many different methods to provide a differential between wheels and allow them to turn independently of each other.

The Canadian National made several tests of this concept by using conventional roller bearings on ends of the axle but with a third roller bearing between the wheel hub and axle in one wheel only of each pair. Their interest was due to a concern about excessive rail corrugation. Their severe problem with rail corrugation was thought to be the result of extreme loading coupled with rotating wheel slip on curves. Mr. Paul F. Giesking of National Steel Car Corporation, Hamilton, Canada, made a report on this problem at the 1969 Dresser Engineering Conference. This report is included in the Technical Proceedings of the 1969 Conference published by Dresser Industries, Inc.

Results of Canadian National's investigation indicated reduced flange contact and wheel slip. On a 12^{o} loop curve it was established that drawbar pull was reduced 30% on cars equipped with the free wheels. Their conclusion was that the concept warranted a more sophisticated investigation.

Seymour F. Johnson of Santa Barbara, California, has submitted information on his patented development of a "Free-Wheeling Railroad Axle." This design consists of a tubular axle tying the two wheels together and mounted over a solid axle that is equipped with conventional bearings. The assembly includes a roller bearing built into each wheel hub and provision for the wheels to rotate separately.

The advantage of this concept over a conventional bearing in one wheel hub like that tested by Canadian National is that, due to the long lever arms of the axles, high stress in the hub bearing from the overturning moment on the wheel is eliminated.

Mr. Johnson and Mr. Giesking exchanged information in regard to the concept and performance of a free-wheel-design truck.

Freight Car Truck Design Optimization, Survey and Appraisal of Type II Trucks, 1975
US DOT, FRA, Southern Pacific Transportation Company