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ODOMETERS FOR RAIL APPLICATION

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16. Abstract

Available mileage counters were evaluated, anticipating the possibility of using mileage intervals, rather than elapsed time, for freight car inspection. Simple, reliable and reasonably low costing devices were required. Only two unpowered mileage counting odometers were uncovered, one built in the U.S., the other in Switzerland. The Swiss device is not currently available in this country, presumably because of its particular suitability to European style trucks. The American built device was tested in eccentric rotation and for accuracy at both low and average freight car speeds. It was concluded that the American unit could serve satisfactorily in freight service, without modification, at what would appear to be acceptable cost levels.

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PREFACE

It has been a concern of the railroad industry that freight cars are serviced on the basis of elapsed time. It was recognized that such maintenance would be more economical if conducted after certain mileage points were reached, rather than being done on a periodic basis. No suitable device for recording mileage seemed available, however.

Simple mileage recorders, odometers, have been in service for some years on trucks and buses as well as on rapid transit vehicles. It seemed worthwhile to examine odometers for the possibility of using them on typical U.S. freight cars.

TSC was asked to examine available devices and comment on their suitability for this application. Investigations and tests were conducted at the Cambridge facility of DOT between July and November 1974.

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1. BACKGROUND

Only two self-contained odometers were found to be presently available to the rail and transit industry. One is a domestic instrument; the other is made in Switzerland. Both are attached directly to axle ends, axle covers or within journal boxes. While one is an inertial device, the other is driven by a link with the axle end. Both calculate mileage from the wheel diameter and its counted revolutions. These two-axle-end odometers are made by Hasler in Berne Switzerland and by Engler in Jersey City, New Jersey.

In contrast to these are several speedometer-odometer devices and/or speed recorders commonly associated with locomotives. Although they would fill the elapsed mileage need, their other characteristics make them unsuited to rough useage on unpowered freight cars.

2. THE HASLER UNIT

The Hasler unit is mounted "on the axle-boxes of railway vehicles" and requires adapters for journal boxes, a cover replacement, and for roller bearings, a bracket. Since it is not an inertial device, it must be fitted with a rotating connection to the axle end.

This odometer has a five-inch circular base flange by which it bolts to many European axle housings. These housings are non-rotating bearing containers with a bolted on, removable bearing cover. The axle end must be adapted for a rotating link to the back of the instrument. The instrument counts in either direction, and its dial reads directly in 2000 mile (or kilometer) increments. It is shop adjusted for wheel diameter – which might require some inventory for several sizes of wheels. This is also true of the U.S. device.

2.1 PRICE AND LABOR

Because there will be a need to build special adapters for U.S. plain or roller bearings, we were unable to determine a firm price for a unit. Hasler offers fifteen different adapters for European applications, none of which fit American cars. The complexity of the device, its gears and mounting adapters, imply a substantial price. A guess would suggest approximately $200 per unit. The unit must be fitted with a rotating connection to the axle end; the combination of this link and the instrument mounting adapters would make the assembly to a rail car axle quite time consuming.

2.2 SPECIFIC CONSIDERATIONS ON THE HASLER MILEAGE COUNTER

2.2.1 Mounting on Roller Bearing Axles

Mounting on roller bearing axles will require special mounting brackets. Since roller bearing end caps rotate with the axle, the bracket must therefore attach to the truck frame. There are

approximately 9 to 15 inches of overhang between car sides and axle ends for nominal car widths of 9 to 10 feet. This would be adequate for the bracket, the instrument (projecting 3-3/4 inches beyond the bracket) and the rotating link between. It would leave about 4 inches, in the worst case, for the connecting link. Since most U.S. truck designs allow some axle motion relative to the truck frame, it seems that this motion would soon destroy the link or its connection to the axle end.

2.2.2 Mounting on Plain Bearing Axles

Mounting on plain bearing journal boxes would require replacement of the cover with a specially designed cover/mounting adapter. The axle center, being lower than the center of the journal box opening, will provide a special problem for any connecting link and an alignment difficulty between the instrument and axle end—even with a special cover. Broken link particles could cause a bearing failure. Cutting away a portion of the curved bottom of the box to permit straight passage of the connecting link would require a complex cover/mounting adapter to insure a tight seal. There is concern for the strength of the cut box.

Journal boxes leave approximately 4 to 16 inches between their outer ends and the car sides on nominal (9 to 10 feet) cars. Since the plain bearing journal box can come within 4-1/2 inches of the car side (with 9 foot cars) it would bring the Hasler instrument flush with the side of the car. A position further under the car would be less vulnerable.

2.2.3 Optional Mounting

Optional mounting in another location is possible and might better protect the instrument. It could be positioned on a bracket or plate in a number of places under, or even within the car. This requires routing of a flexible cable to produce minimum bends. Some means of cable connection to the axle end would still be necessary, and the adapter problems mentioned above would be similar if not identical. Earlier TSC investigation of speed in-

dicators and recorders found that rail industry experience with cable drive durability was very poor.

3. THE ENGLER "REVO-COUNT"

The Engler "Revo-Count" is adapted to mount on roller bearing end caps, or within the journal box on plain bearing axle ends. The latter position requires the axle end to be drilled and tapped for the instrument stud. A heavy duty construction is used in railroad application, and these units are often specified on new locomotives coming from GM's Electromotive Division and GE's Erie Works. The instrument counts up when rotated in either direction and is factory adjusted for the wheel diameter intended. It is marked to show wheel size and reads mileage directly.

3.1 PRICE AND LABOR

Instrument price varies between $60 and $100 for one size and $44 to $73 for another depending on quantity. This price includes the adapter bolts and mounting plates for roller bearing axles.

It takes approximately five minutes for one man to attach one Engler instrument to a bearing end cap. "Lost" time – moving from wheel-to-wheel, picking up tools, getting additional parts – will add an average of another two minutes per axle.

3.2 SPECIFIC CONSIDERATIONS ON THE ENGLER "REVO-COUNT"

3.2.1 Roller Bearing Mounting

Roller Bearing Mounting kits are available having three drilled and tapped replacement bolts for those in the bearing end caps. Those bolts accept three smaller bolts holding a plate which mounts the instrument in a slightly "stand-off" position. There are two models of these kits: a Timkin bearing adapter, and a "Railroad Universal (roller bearing) Mount."

3.2.2 Plain Bearing Mountings

Plain bearing mountings are made within the journal box and require that a 3/4" hole be drilled and tapped into the axle end.

The journal box affords protection for the instrument. This application requires that instruments be ordered with a 3/4" threaded mounting stud; the standard is a 1/2"-20 stud. Axle threading is generally done on new axles, before being fitted with the sleeve bearing and, of course, off the car. There should be prior knowledge that axle odometers may be mounted on these cars. Some properties require that axle ends be drilled, tapped and countersunk. A bolt may be inserted to protect the countersink used later for centering purposes when the wheelset is in need of recutting the rims. If a 3/4" hole with appropriate thread is specified in such cases, the axle ends are capable of odometer mounting whenever desired. The time required to mount an odometer into an axle already prepared is considered a very liberal two minutes.

3.2.3 Operational Mounting Location

Various optional mounting locations were examined for feasibility. The next section describes the most promising alternate location: under the car, rotating around the axle.

3.3 TESTING ENGLER OPTIONAL MOUNTING

3.3.1 Eccentric Rotation

With the understanding that the largest axle has an 8-9/16-inch diameter at its center and that the instrument has a 4-5/8-inch diameter, fixtures were divised to rotate the Engler instrument on a 6-3/4-inch radius (see Figure 1).

The instrument on hand ("Revo-Count, 32 in. Dia. R.R.") was factory adjusted for wheels traveling 8.378 ft per revolution. This equated to 628.55 revolutions per mile, and from this 209.5 rpm was determined to be the equivalent of 20 mph, reportedly the average freight car speed (see Figure 2).

Eccentric rotation tests were done at 20, 45, 48, 60 and 80 rpm. Rotation was not attempted at the 20 mph speed because intermittent "hang up" occurred at 48 rpm, and the odometer would not count at all at 60 and 80 rpm. It is suspected that the weighted mass either bound against the case or caused excess friction on the

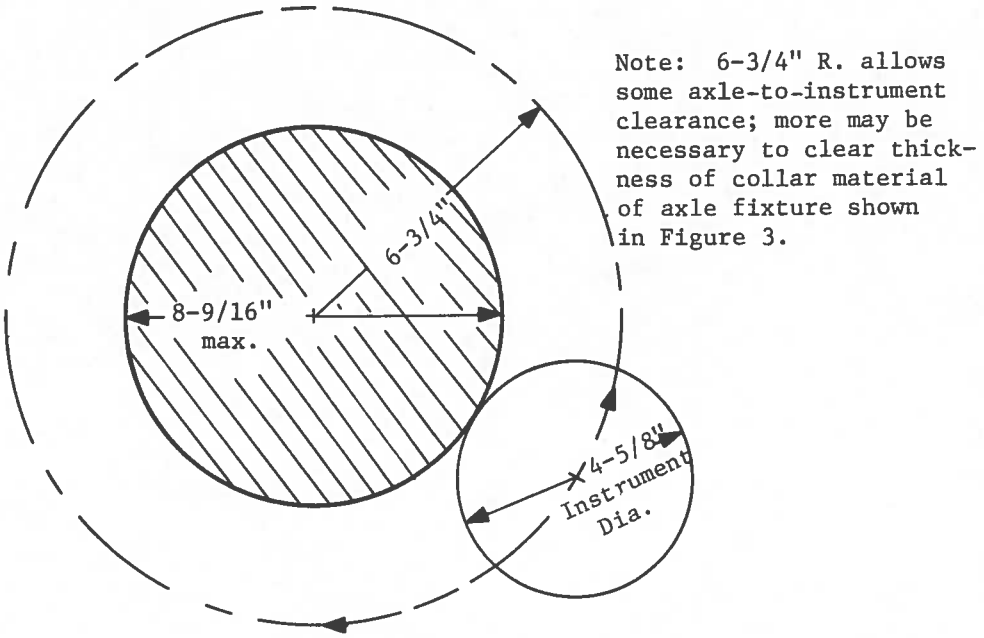

Figure 1. Eccentric Rotation

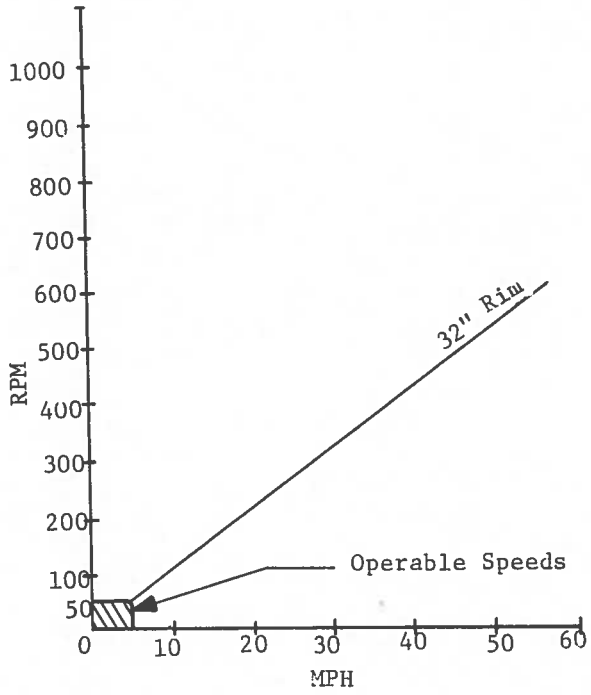

Figure 2. Rotation Speeds for Eccentric Mount Tests

center pivot. The solution to either cause would entail significant design problems.

If hang up had not occurred at the lower speeds, it had been intended to attempt the higher speeds on a simulated axle fixture similar to Figure 3. Such a test would have required a counter balance to the centrifugal force of the instrument.

3.3.2 Accuracy

A check was made on the instrument's accuracy while rotating at the 20 rpm speed. This is approximately 2 miles per hour. In one hour's rotation (1257 turns) a 5% error was recorded; the instrument read short by 0.1 mile.

An additional test of one hour's running at the 20 mile per hour rate (209.5 rpm) was also done for accuracy at the center of rotation (not eccentric). The error, if any, was less than 0.1 mile – i.e., the smallest increment of the readout.

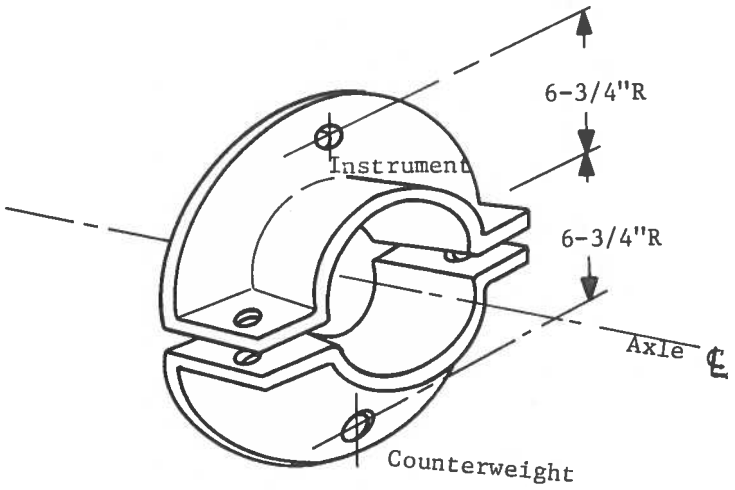

Figure 3. Axle Fixture for Under Car Mount

3.3.3 Clearance Considerations

If the Engler "Revo-Count" were to be mounted on axle shafts with a fixture similar to that in Figure 3, consideration would have to be given to clearance of such things as draft gear and brake rigging, which will vary depending on the car. Additional clearance must allow for relative motions of the under-car equipment, as well as axles and truck actions.

A grease fitting that bypasses the odometer brackets on the roller bearing end caps may be desirable; otherwise, instruments will have to be removed in order to lubricate bearings. Alemite was mentioned; it is believed they have provided such by-pass grease fittings in the past.

3.3.4 Instrument Protection

There is some concern that the exposed position on the axle end (roller bearings) may invite damage and vandalism. It does appear, however, that the instruments' smooth, flat shape and very tough, plastic oval face, plus its under-the-car edge location will make damage relatively rare. Bus experience has shown little damage. The instrument is tamper-proof; it has no openings.

Protection of axle-end instruments might be possible by means of mounting within a heavy cup-like sleeve (see Figure 4). An assembly problem becomes evident upon consideration of the sequence of events when assembling parts to the end caps. Cutouts could be provided as indicated so as to turn the bolts into the larger, drilled and tapped bolts (it might be difficult to get the threads started); or, possibly the nut for the odometer stud could be tack welded over the cup center hole. The cup might then be mounted, followed by the instrument stud threaded into the mounted cup. Turning the instrument could be aided in tightening into the tack welded nut by a clamp-like tool with rubber covered clamping fingers. This might minimize pilferage by making loosening of the instrument very difficult without the tool.

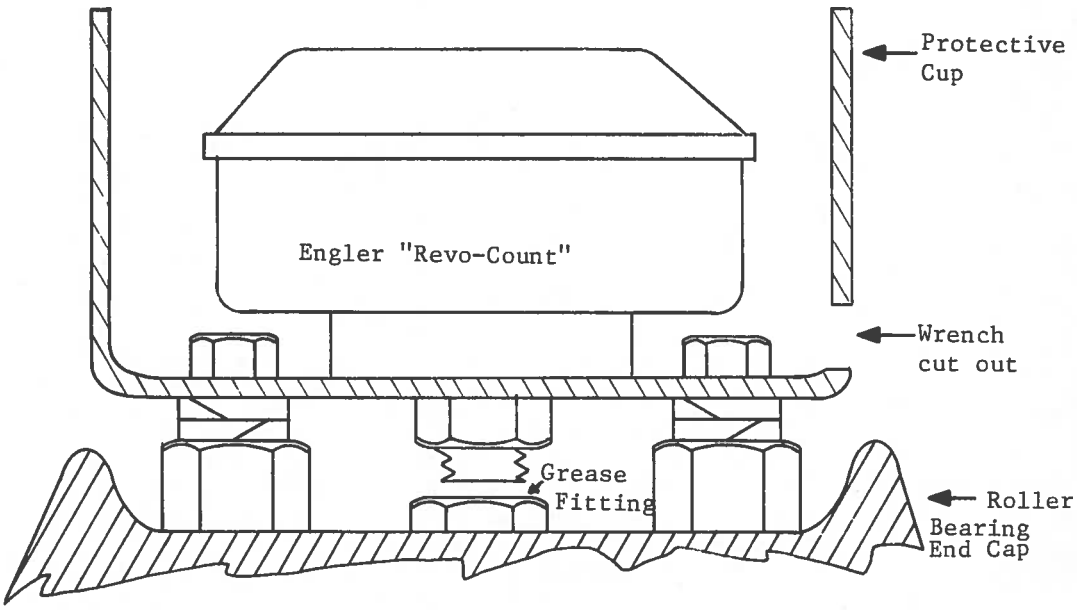

Figure 4. Protective Sleeve for Axle End Mount

4. RECOMMENDATIONS

In reviewing the several considerations above – i.e., adaptability, price and probable assembly labor costs, simplicity and application with the least engineering – the Engler unit is prefered.

The Swiss odometer could be used on plain bearing journal boxes only after engineering consideration of cutting into the box structure and of a short, off-set link to a new connection to the axle end. A yet-to-be-designed instrument bracket for roller bearing axles would involve the critical effect of up and down axle motion on the axle-instrument connecting link. Both situations raise concerns about costs, reliability and perhaps safety.

The Engler device is often seen on buses and earth moving equipment and is in use on rapid transit rail service. All verbal statements indicate satisfactory service – buses in Kansas City and Seattle, Transbus development vehicles, and MBTA transit.

Revo-Count (Engler) instruments should be mounted in nominally "on center" locations. They are environmentally tough (sealed shock resistant and tamper proof), but there is no information on applications which might offer extreme shock (100G). The Metroliner is said to experience as high as 90G at the trucks at high speed; however, the GM and GE locomotive applications speak well for the Engler unit's ability to perform under heavy duty usage.

There is every reason to conclude that the Engler unit would perform well in freight applications when operated as suggested by its manufacturer.

SOURCES

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