COMMERCIAL TRANSPORT.

PAPER

COMMERCIAL TRANSPORT.

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One particular phase of commercial transport will be considered, and that is the use of trailers with road transport vehicles.

Section i will be an introduction.

Section ii will relate to types of trailers.

Section iii will relate to details of design.

Section i.

The trailer vehicle is the towed vehicle. The ox cart, the wagon, etc., have the same fundamental principles as the modern trailer. However, trailers attached to road vehicles were probably not widely used, if at all, until the motor truck was a well-established part of our transport system, and roads were reasonably good. The mechanical difficulties connected with the development of motor trucks were some years in being overcome, and obviously the first job was to develop the powered mover. Makers and merchandisers of trucks desiring to sell greater numbers of trucks were not inclined to encourage the use of trailers, which would obviously adversely affect the number of trucks required. This is not the case to-day, as some truck manufacturers either make themselves or have made independently trailers for use in conjunction with their trucks, and as an aid to truck sales. The fact that the truck could pull more than it could carry suggested the attachment of a trailer.

Steering defects appear to have delayed the popularity of the early four-wheel trailers even more than opposition from merchants, but, as usually is the case, manufacturers set to work to overcome such defects and evolve a sound and useful vehicle. Records show that in 1914 a Belgian named Pescatore patented a design for using a half-chassis for carrying the load, suspending the front end of this chassis on the rear end of the truck chassis by the use of a fifth wheel or turntable. This was the first semi-trailer. The coupling consisted of (1) a vertical pin on a turntable mounted on a tractor, and (2) a hook swivelled on the front end of the trailer in such a manner as to permit the trailer to meet uneven ground conditions, independent of the action of the pulling unit. Screw jacks of the house-moving variety, fastened to each main frame near the front end, acted as supports when the tractor was uncoupled. Since this crude vehicle was introduced many changes, variations and improvements have been made. In U.S.A. building around this patent semi-trailers were made to various designs such as one by Martin,
in which the rocking action was allowed to act at the flat plate turntable. At this point the defects of the four-wheel trailer with knuckle type-steering were still objectionable, and the semi-trailer gained ground.

In 1925 the Trailer Co. of America produced an automatic trailer known as the Interlocking Type, in which the feature was that the tractor could automatically disengage from the trailer—a great time-saver when one tractor was in use with a number of trailers. Trailer development in Australia followed similar lines, starting with the improvised vehicles of carriers for special and awkward loads.

About 1920 trailers and crude types of semi-trailers were in use in Melbourne.

In U.S.A. the trailers registered in 1938 numbered 1,096,396, and trucks numbered 4,224,031, a proportion of one trailer to every four trucks approximately.

Section ii.

Trailers may be arbitrarily divided into four groups—

(a) Two-wheel trailers, such as those towed behind private cars (the single-wheel trailer can be included here).

(b) Four-wheel commercial trailers.

(c) Commercial semi-trailers.

(d) Heavy special purpose multiwheel trailers.

Trailers (a) will not be considered here.

(b) The four-wheel trailer is very suitable for occasional use with the motor truck. It can be readily coupled to any truck provided with a suitable hitch, and when pulled by the loaded truck can itself carry a payload of up to 80% of the truck payload without greatly affecting truck performance. It enables the full tractive capacity of the truck to be used, the combined payload of truck and trailer being about 80% more than regulations would permit the truck alone to carry.

A truck carrying its maximum, say 4½ tons payload, can comfortably pull a trailer carrying 3¾ tons payload. In Australia four-wheel trailers are mostly of capacities from two tons to six tons payload, and of sizes from 12 ft. x 6 ft. to 14 ft. x 7 ft. at decks.

The four-wheel trailer comprises two axles with wheels, the front axle arranged for steering, a frame carrying the deck and a drawbar for coupling to a truck. The greater proportion are fitted with a turntable permitting a 90° lock, while others have steering similar to modern trucks, giving a lock of about 25°. The advantage of the turntable type is, of course, its ability to
turn in a relatively small space, while its disadvantage is the tendency of the front wheels and drawbar to jerk violently when the front wheels strike even small obstructions. With a turntable moving too free, the trailer tends to hunt.

The truck type steering overcomes to a large extent excessive deflection of the front wheels, but has the disadvantage of a relatively larger turning radius. The loading height of the truck type steering trailer can be made about four inches less than most turntable types, which is about 48 inches. Four-wheel trailers cannot be backed when coupled to the truck except by very skilful drivers. This is a notable disadvantage.

(c) The commercial semi-trailer, as used in Australia, is generally left permanently fitted to the truck chassis. The arrangement of tractor (pulling vehicle) and semi-trailer is fundamentally as outlined in Section i, the semi-trailer front pivoting in a vertical plane from a turntable fixed to the tractor chassis above the rear axle, capable of oscillating in a horizontal plane, and the rear of the semi-trailer supported by another axle and wheels. The principle of a truck being able to pull more than it can carry also applies to semi-trailers. A semi-trailer unit comprising a five-ton truck chassis and a semi-trailer would carry a payload of eight tons, whereas the five-ton truck and tray would carry approx. 4½ tons payload. In other words, the semi-trailer unit capacity is nearly 80% greater than that of the truck. The semi-trailer can be handled and manoeuvred as easy as a truck, turned easily in the same or even less space, backed just as readily, and has the additional length for long loading. It has only one extra axle, and, consequently, less wearing parts, and it can be cheaply produced.

The two most popular types of semi-trailer units are the flat deck type and the jinker type. Many other variations are made for special purposes. The most common example of the jinker type is the semi-trailer used for a log or sawn timber transport. This comprises the usual turntable on the tractor chassis and a transverse bolster across the turntable. A pole is pivoted on the front bolster across the turntable, and is free to move in a vertical plane. This pole connects by means of adjustable clamps to a rear bogey having a transverse bolster carried on an axle and two wheels. Sizes of commercial semi-trailer units range from 16 ft. x 7 ft. to 32 ft. x 8 ft. deck size, and have capacities of up to ten tons payload. The regulation thirteen-ton gross road limit more or less limits payload to ten tons, but in parts of the Riverina, on unmade roads, loads of up to sixteen tons are common. Jobs for use in these parts are usually made much stronger than those designed for city to country carriers, whose main concern is low tare weight.
A special feature of the semi-trailer is that one tractor can be used conveniently with a number of semi-trailers. This feature provides a transport system known as shuttle operation. For instance, two semi-trailers are at a loading station and one is coupled to the tractor, and the other is free and supported by dolly or jockey wheels extending down from the chassis at the opposite end to the axle, and capable of being raised or lowered. The coupled semi is loaded first and proceeds to the unloading station, where the tractor is then uncoupled and proceeds back to pick up the other semi at the loading station. Properly planned, this system shows great economy, and is widely used in U.S.A. An example of this system is provided by the Jos. Schiltz Brewing Co., Milwaukee, U.S.A., and is as follows:

The Jos. Schiltz Brewing Co., Milwaukee, has in a very unusual way solved a problem of hurriedly unloading empty beer kegs from incoming freight cars. It was important to combine speed with efficiency to save demurrage, to increase production, and keep their standing inventory on empty kegs as low as possible. Representatives of the Highway Trailer Co. were consulted, and a shuttle plan was worked out whereby more than 25 big freight cars could be easily unloaded within a day. The Schiltz Co. bought eight fully automatic 100% cab-controlled trailers and two tractors for use in the proposed shuttle service. A tractor hauls an empty trailer to the doorway of a loaded freight car, uncouples, and moves on to another freight car, where a trailer loaded with empty kegs is waiting to be hauled to the company’s washhouse, only a few feet distant. Dropping the trailer at the washhouse, the tractor picks up an emptied trailer, takes it back to a freight car for reloading, picks up another already loaded trailer, and repeats the endless process. It is estimated that each of the eight trailers is picked up and dropped from 20 to 40 times daily. This fast operation is facilitated by the full automatic cab control, which gives instant connection and disconnection of power brakes and lights without the driver leaving his seat. It is interesting to note that all eight trailers and the two tractors operate entirely within an area of less than a city block. The brewing company, it is said, has found this arrangement to be eminently satisfactory. It fills not only the requirements of lessening demurrage and stepping up production, but also opens up all the company’s direct railroad sidings for the exclusive use of outgoing shipments. Thus production on both ends is carried on uninterruptedly and independently. In addition, the company uses a municipal type side-dump trailer for rubbish and snow clearance. This auxiliary trailer is pulled by one of the tractors at convenient odd times.

Long-distance transport companies in U.S.A. have similar schemes in operation, and, by means of terminal loading stations,
in one instance the Robertson Freight Lines, Oregon, U.S.A.,
operate 29 semi-trailers with only sixteen tractors. This company
has a fleet of vehicles comprising fifteen trucks, sixteen tractors,
all Diesel driven, and 29 semi-trailers, and the yearly mileage is
approximately 750,000 miles.

The All States Freight Line, of Akron, U.S.A., began opera-
tions with 50% straight trucks and 50% tractor trailers, but,
after actual operating experience, the proportion of straight
trucks was reduced to 5%, the 95% being semi-trailer units.
Leading carriers in Melbourne appreciate this feature, and have
semi-trailers of various sizes and capacities made so that all are
readily fitted to any tractor. Scammel mechanised horses, as
used by Australian Glass Co., illustrate this feature.

The variety of semi-trailers is almost unlimited, and it may
be of interest to mention a few: Tanker trailers handling oil,
beer, vinegar, milk, water, etc.; stock structures, double and
treble deck for horses, cattle, and sheep; refrigerator trailers for
milk, rabbits, etc.; vans for furniture by the houseful, photo-
graphic studios, racehorses, general merchandise; jinkers for
poles, logs, and sawn timber; flat decks for wheat, wool, fruit,
oil in drums, general goods; semi-trailer hydraulic tip trucks, for
coal, metal, sand, etc.; semi-trailers for passenger transport.

(d) Heavy special-purpose multi-wheel trailers in this
country and U.S.A. are generally semi-trailers, while in England
a heavy type of two-axle trailer is fairly widely used as well
as the semi-trailer. These heavy vehicles are generally of the
drop-frame or gooseneck type, wherein the main members drop
to a lower level behind the tractor. The general requirement
is low loading, high capacity, a wheel arrangement to give even
tyre loading under all conditions, and a flexibility to ensure
stability. This type of trailer is made to carry loads such as
tractors, heavy machinery, power shovels, road rollers, boilers,
long girders, etc. Lengths range from 16 ft. to 30 ft. or more,
widths up to 9 ft., capacities from 10 to 100 tons. Special road
permits are necessary for many of the larger loads. The number
of tyres on the rear may be sixteen or more, and each tyre is
able to take an even share of the load by means of oscillating
axle assemblies. A type useful for carrying excavators is made
with easily detachable rear wheel assemblies to facilitate loading,
the excavator being run on to the trailer under its own power.
The low loading height permits the use of ramps at small angles,
and facilitates the removal of high packages from stores and
sheds, etc. Springs are not fitted as a rule, and as speeds are
usually under 20 m.p.h., sufficient resilience is given by the
pneumatic tyres.
Section iii. Details of Design—Trailers up to 10 Ton.

(a) Tyre Capacity.—Due to enterprise and research of the large companies now manufacturing pneumatic tyres, a wealth of information is available with regard to selection of tyres for commercial vehicles. Manufacturers’ handbooks give proven figures as to tyre-carrying capacities, and so it is quite easy to choose correct tyre sizes when the loads are known. But, despite all the care in manufacture, the quality of tyres varies, and apparently identical tyres show a marked difference in performance under exactly similar conditions. Fortunately this is comparatively rare, and the reason for undue tyre wear is generally attributable to other causes. The most general cause is overloading. When overload is practically unavoidable, offset its effect on the tyres by keeping speed to a minimum. Friction, flexing, and temperature are then kept at a minimum, and consequently excessive wear prevented. Exhaustive study of tyre operating conditions has established recognised standards in this respect, as shown in the following table:—

<table>
<thead>
<tr>
<th>Load per tyre %</th>
<th>Mileage Expectancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underloaded 20%</td>
<td>160% of normal mileage.</td>
</tr>
<tr>
<td>Correct or 100% load</td>
<td>Normal or 100% mileage.</td>
</tr>
<tr>
<td>Overloaded 20%</td>
<td>70% of normal mileage.</td>
</tr>
<tr>
<td>Overloaded 40%</td>
<td>50% of normal mileage.</td>
</tr>
<tr>
<td>Overloaded 60%</td>
<td>40% of normal mileage.</td>
</tr>
<tr>
<td>Overloaded 80%</td>
<td>30% of normal mileage.</td>
</tr>
<tr>
<td>Overloaded 100%</td>
<td>25% of normal mileage.</td>
</tr>
</tbody>
</table>

It is estimated that an increase in tyre temperature from 75° to 85° F. will result in a reduction in tread mileage of approximately 13%. Tyres running at 25 m.p.h. will give 20% more tyre life than those run at 35 m.p.h. Tyres underinflated by 15% reduces tyre mileage by 10%. 60% normal inflation results in tyre mileage 43% of normal.

Certain mechanical defects will result in abnormal tyre wear. Such defects may be axle misalignment due to sheared centre bolt in spring, springs of uneven temper and deflection, worn shackles, worn bearings, distorted rims or disc wheels, improperly fitted wheels, loose drawbar connections, bent axle, excessive freedom of turntable. The effect of centrifugal force on the front wheels of a four-wheel trailer when cornering affects tyre wear, and also causes uneven spring deflection, which, in turn, causes temporary axle misalignment and tyre wear. When dual wheels are fitted, as on most semi-trailers, the trailer tyres always wear more than the duals on the truck. Agreement is not yet reached on the reason for this. The semi-trailer wheels follow a better curve than the four-wheel trailer wheels, and side
skidding is a minimum, but dual wheels must wear, due to road camber and cornering. To overcome this difficulty, differential dual wheels are available in U.S.A., while in England a flexible joint is fitted between dual wheels to provide limited self-adjustment for road camber. The most popular sizes of tyres in general use on commercial trailers in Victoria are 32 x 6 x 10 ply and 34 x 7 heavy duty, both high pressure tyres with rated capacity of 2200 lb. and 2800 lb. each respectively. Normal inflation pressure is 80 and 85 lb. sq. in. respectively, and at speeds under 20 m.p.h. the recommended loads may be increased by 35%. Dual tyres carry twice the load of the single tyre. Tyre sizes are the chief factor used by the authorities in assessing gross capacity. For instance, a four-wheel trailer on four 32 x 6 x 10 ply tyres, and having a tare of 25 cwt., would be rated four tons gross plus 10% overload, the nett payload being approximately 3.15 tons.

(b) Types of Wheels.—Trailer wheels are quite often interchangeable with the truck wheels, and may be one of two types. The spoke wheel, to which is fitted one or two demountable rims, has six radial arms or spokes integral with the hub. The outer ends of the spokes are machined to carry the rim or rims, which are held securely by means of clips and bolts. These rims, upon which the tyres are mounted, are quite easily removable. The rims are formed, rolled, buttwelded, sized, and trued to close limits, and comprise rim, flange, and locking ring. The steel used for rims and disc wheels as far as I can ascertain is about SAE 1045. Rims have the advantage that they are almost universally interchangeable. Both the rim and the wheel are provided with a shoulder tapered at 28°, and the rim is clipped hard against the shoulder of the wheel. Popular rim sizes are 20 x 6, 20 x 7, which take 32 x 6 and 34 x 7 high pressure tyres and the interchangeable balloon tyres.

The wheel hub is located so that the load comes slightly nearer the inner ball race, and its length is about one-sixth of the diameter outside of tyres. Both cast steel and malleable cast iron are used for spoke wheels. An advantage is claimed for spoke wheels in that the air currents generated help to cool the brakes. Disc wheels comprise a rim, as previously described, to which is rivetted a dished and perforated centre plate. The disc wheels, single or dual, are made with suitable offset, and are secured by means of self-centring studs to a flanged and spigotted hub. Various makes of trucks vary the details of their disc wheels, and so there is a lack of interchangeability between the various makes (Fig. 1).

(c) Bearings.—Super-rolled bearings are the general rule in trailer wheels. The sizes are calculated by the usual methods,
with a generous overload margin. This is done purposely to ensure long life in the only part of a trailer which can practically be called a working part. Even though larger size axles are therefore necessary this policy has proved worth while. It is not uncommon for trailer bearings to give 250,000 miles trouble free.

On the semi-trailer the thrust loads on bearings are not relatively as great as those on the front wheels of a four-wheel trailer. A method of calculating such loads is given by the Timken Bearing Co., and is shown on Fig. 2. The usual factors and ratings are then used to determine the most suitable bearings. Bearings successfully used on four-wheel trailers of capacities four to six tons have bores as follows:—Inner bearing 1.77 in., outer bearing 2.36 in. Semi-trailer axles of eight-ton capacity have bearings of 2.56 in. bore, and for ten-ton capacity 2.95 in. bore bearings are used.

The effective enclosure of the bearings on the outside is by means of a gasket and cap. On the inner side of the wheel around the stationary axle probably the most effective method is when a labyrinth seal is used as illustrated on Fig. 3. Other methods are used, but the most important point is to protect the felt seal from moisture and dirt. Most bearing trouble arises from faulty sealing. This seal has been adopted as standard by the Department of Defence for nearly all its trailers and all the artillery wheels. Comparatively few trailers have axle camber or wheel toe in. Square axles are fitted both on the square and on the diamond, but this is only a matter of individual preference, as it is well known that as the modulus of section of the square is \[0.167 \frac{S}{h^3}\] and the diamond \[0.118 \frac{S}{h^3}\], the square is \[\frac{0.167}{0.118} = 1.41\] times, or \[41\%\] stronger size for size. Comparing a square axle to a round axle, both of equal section modulus, it is found that the weight of the latter exceeds that of the former. For instance, a three-inch square axle has the same section modulus as a 3.57 in. diameter axle, but the round axle is approx. \[1\frac{1}{2}\] times heavier than the square. The square axle also provides a simple seating for the semi-elliptic springs.

(d) Axles and Springs.—Springs are generally semi-elliptic, and have approximately 5 in. camber and centres 39 in. to 42 in. Typical three-ton springs comprise eleven silicon manganese (SAE 9255 and 9260) graded leaves, each 3 in. \(\times \frac{7}{8}\) in. 5 in. camber 42 in. eye to eye, while four-ton springs would have thirteen leaves of similar size. Rebound springs are not generally used on trailers in Australia, but sometimes dual springs are fitted on long semi-trailers to minimise side sway. The usual type of spring shackling is used, and is of rugged construction.
(e) **Chassis.**—The chasses of commercial trailers built in Australia are formed with standard rolled steel sections, and the safe stress used is 18,000 lb. tensile. This has proved quite ample for most overloads. The pneumatic tyres lessen road shock, but ample shear strength should be provided to overcome failure by fatigue. For instance, it has been noticed that sections such as 4 x 1½ RSJ fail with small cracks, and more particularly rear welds. Even bracing members fail near the welds, apparently through vibration, if the lap joint is not of sufficient length. On five-ton trailers 14 ft. x 7 ft., the main members are never less than 4 x 2. On semi-trailers 16 ft. to 24 ft., the main members are 5 x 2½ or 6 x 3, sometimes plated or trussed. Larger members are trussed or fish bellied. The girders are designed generally for uniformly distributed loading, and as beams overhanging two supports. The fish-bellied girder gives strength at point of maximum bending, and affords wheel clearance with minimum height (Fig. 4). Girders must clear the wheels and chassis when at 90° lock, and on uneven ground contours. On a 22 ft. semi-trailer the turntable could be in four feet from the front end of the tray, and the rear could overhang the axle by four feet. This assumption provides a safe and easy condition to determine beam sizes, and as attempts are made to standardise design there does not appear to be need for a more accurate calculation of stresses. Under special conditions, such as when 2-4 ton cable drums are to be carried, more exact calculations are made.

A semi-trailer, 22 ft. long, capacity 8½ tons payload, complete with a 1 in. hardwood deck, frame, springs, axle, wheels, turntable, and sub-chassis, would weigh 33 cwt. Gross weight of tractor and trailer unladen would be around 4 tons 5 cwt., therefore the proportion of payload to unladen weight would be 2 to 1. In the case of the four-wheel trailer, carrying three tons payload, and taring unladen 25 cwt., the proportion would be 2.4 to 1.

In U.S.A. and England by the use of alloys such as stainless steel, duralumin, etc., lower tares are obtained, but of course first cost is higher. It is important that the load from the semi-trailer be transferred to the correct position on the truck. This load is more concentrated on that imposed by an ordinary truck body, and on some makes of trucks it is advisable to strengthen the truck chassis by means of steel runners U bolted to the top of the chassis. Incidentally, this is a simple method of fixing the semi to the tractor. The position of the turntable, therefore, is placed a certain distance ahead of the truck axle, to provide the proper loadings on the three axles. It may prove
helpful to set out loadings on a typical semi-trailer unit, using the following data:—Length, 22 ft., with 4 ft. overhang at each end; payload, 83 tons; tare of semi, 1.65 tons; tare of tractor chassis, 2.85 tons, equalling 13 tons gross:—

Unladen load on tractor front axle, 1.6 tons.
Unladen load on tractor rear axle, 1.25 tons.
Unladen load on trailer axle, .95 ton.
Unladen load on trailer turntable, .7 ton.

Turntable, 10% of tractor wheelbase ahead of axle.

Gross load on semi axle = 4.25 t. + .8 t. = 5.05 t., say 11,400 lb.
Gross load on tractor rear axle = (4.25 + .7) .9 t. + 1.25 = 5.6 t., say 12,500 lb.
Gross load on tractor front axle = 1.6 + .5 = 2.1 ton.

Gross tare would be 13 tons maximum, distributed in proportions 40%, 44%, 16%.

Tyre loads on semi would be 2950 lb. each approximately.
Tyre loads on tractor rear would be 2970 lb. each approximately.
Tyre loads on tractor front would be 2500 lb. each approximately.

34 x 7 HP tyres would be fitted, and payload would be slightly less than the 83 tons. The gross load on the tractor would be 7.7 tons.

If this tractor was used only as a truck, and carried 4.5 tons nett payload (7.5 t. gross, less 3.25 t. tare), the comparison with the semi-trailer unit would be approximately 8 tons to 4.5 tons. The cost of a truck chassis for use with a semi-trailer for loads around 9 tons, plus the cost of the semi, would be approximately £700, whereas the cost of a truck to carry 8 tons would be around £1500. The semi-trailer petrol consumption is about 2 m.p.g. more than the tractor with a truck body. The running cost of a semi-trailer unit as mentioned above would be approximately 4d. per mile, while for a truck to do the same work the running cost would be approximately 5½d. per mile. A semi-trailer increases the capacity of a truck chassis by around 80%.

The tractive or rolling resistance on average roads is around 50 lb./ton, and therefore a nine-ton semi will put an extra 250 lb. pull on to the tractor. This means that, instead of peak performance on the standard 2% grade, it will occur on a 1½% grade, which, however, is quite acceptable for semi work. Assume normal top gear tractive effort of truck = 695 lb. with eight tons gross on 1.8% grade. Assume 20 lb./ton gross for each 1% grade.
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\[
\frac{5 \times 20}{100} = 0.4
\]

\[
\frac{250}{100} = 1.4
\%
\]

...grade attainable with semi = 1.8 - 0.4 = 1.4%.

(f) Decks and Coaming.—Trailer decks follow truck practice, but in Australia the boards are mostly run transverse, as this suits chassis design. Some American designs have steel members transverse across the main girder, with the deck planks running longitudinally. Most Australian trailers have two steel coaming members running parallel with the main girders and across the ends, and the floor ends are supported on the bottom inner flange and held secure by wooden runners fitted into the bosom of the steel joists. For cartage of oil drums in particular, angle iron coaming is used.

Fig. 5 shows a typical deck and coaming arrangement.

(g) Turntables and Steering.—Turntables are most generally used on four-wheel trailers, and there are many variations to the two flat plate type. This is still a very satisfactory arrangement, has large bearing area, and wear is negligible. The pull may be taken on the periphery or by large centre bosses, male and female, in which case the spring-loaded king pin is merely precautionary. The turntable of a four-wheel trailer is better if not too free to rotate, as this causes hunting.

Some turntables are spring loaded at the pivots, to lessen shock to the truck transmission. As the point of pull of the turntable on a semi is nearly over the back axle of the tractor, the vehicle steers very well, but in the case of the four-wheel trailer the point of pull is often 4 ft. to 5 ft. behind the truck axle, and consequently oversteering of the truck is amplified at the trailer.

(h) Drawbars.—Drawbars on four-wheel trailers of the turntable type are triangular in shape as a rule, and connect at one end by two pins to the shackle hangers or front bogey of the trailer, free to pivot vertically. The other end has a single pin or universal connection to the hitch of the truck. Sufficient length is allowed to permit the truck to turn approximately 90° before fouling the drawbar. Chains are required by regulation to connect the trailer to truck.

Various types of quick release hitches are used, with spring-loaded locking devices, to take a fixed pintle on the end of the drawbar. These types of hitches are often fixed to a leaf spring mounter transverse across the rear of the truck chassis. The pin-type connection is often spring loaded at either the drawbar or the hitch. There should not be an excessive play fore and
aft in the drawbar connection, as excessive bumping can easily impair the truck transmission.

(j) Brakes.—Brakes on trailers are not generally compulsory in Victoria, but in the mountainous country in Gippsland many timber trailers have to be fitted with brakes by order of the transport authorities. Power brakes are preferred, and on semi-trailers carrying up to ten tons, brakes having a lining area of between 250 to 300 square inches have proved satisfactory—about 40° in. per ton gross. On four-wheel trailers 150° in. area is ample. In U.S.A. many elaborate braking systems are in operation, some automatically braking the trailer slightly before the tractor in order to prevent jackknifing, that is, the trailer pushing forward on to the truck when a sudden stop is made. The systems used here, mechanical, vacuum, and air-operated, have a separate control conveniently located, by which the driver can first brake the trailer before he applies the tractor brakes. Brakes on four-wheel trailers are fitted for operation from the truck when desired, and have a parking control as well. Undoubtedly trailers have a useful place in commercial transport.
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