

UNIT 3

TYPES OF CONSTRUCTION

- * There are **three basic types** of bus manufacturer:
- * **Chassis manufacturer** - builds the **under frame** in a **body-on-frame** type construction
- * **Body manufacturer** - builds the **coachwork** a **body-on-frame** type construction
- * **Integral manufacturer** - builds **entire buses**, often using no under frame at all. Manufacturers may also be a combination of the above, **offering chassis only** or **integral buses**, or **offering bodywork only** as used on integral buses.
- * The splitting of body and chassis construction allows companies to specialize in **two different fields**.
- * It also allows differing offerings of product to customers, who might prefer different chassis/body combinations.
- * For the manufacturers, **it lessens the exposure** if one or the other goes out of business.
- * **Larger operators** may also split orders between different **body/chassis combinations** for shorter delivery schedules.

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- × Sometimes, a **chassis** and **body builder** will offer an exclusive combination of one body on one chassis, as a '**semi-integral**'.
- × This **combines the expertise of the two companies**, and saves the cost of making their chassis/body usable on different products.
- × Often builders, such as **Duple Metsec** will assemble products into kits, for export and local assembly at a partner site.
- × Large users of **transit buses**, such as **public transport authorities**, may specify specific features that a bus design must feature.
- × This practice was notable in the **Transport for London bus specification, and predecessors**.



A Mercedes-Benz O405 integral bus

CHASSIS

The chassis combines:

- × **A structural under frame**
- × **Engine and radiator**
- × **Gearbox and transmission**
- × **Wheels, axles and suspension**
- × **Dashboard and steering wheel and driver's seat**
- × Chassis will often be built as complete units, up to the point of being drive-able around the factory, or on the public highway to a nearby bodybuilder.
- × **The chassis** can be **front-engined, mid-engined, or rear-engined**. **Most chassis will mount the radiator at the front**, irrespective of engine position, for **more efficient cooling**.

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- * **Chassis products** will often be available in **different standard lengths**, even produced in **articulated variants**, and often be used **for both bus and coach bodywork**, such as the Volvo B10M.
- * **The same chassis** may even be used for **single- or double-decker bus bodywork**.
- * **Chassis builders** may also offer **different options for gearbox and engine suppliers**.
Chassis may also be built in **multiple axle configuration**.

A Volvo B10M chassis, bodied worldwide as a single decker bus, articulated bus, double decker bus, and coach.



BODYWORK

The **bus body builder** will build the body onto **the chassis**.

- * This will involve major consideration of:
- * **Usage**
- * **Seating capacity**
- * **Staircase position/design (double-decker buses)**
- * **Number and position of doors**

Bodywork is built for **three general uses**:

- * **Bus**
- * **Dual Purpose**
- * **Coach**

Bus bodywork is usually geared to short trips, with many transit bus features.

Coach bodywork is for longer distance trips, with luggage racks and under-floor lockers.

Other facilities may include **toilets** and **televisions**.

- × **Bus Body** means the portion of a bus that encloses the bus's occupant space, exclusive of the bumpers, the chassis frame any structure forward of the forward most point of the windshield mounting.
- × A **dual purpose design** is usually a **bus body with upgraded coach style seating**, for longer distance travel.
- × **Some exclusive coach body designs** can also be available to a basic dual purpose fitment.
- × **In past double-deck designs**, buses were **built to a low bridge design**, due to **overall height restrictions**.
- × .



Interior of the Alexander ALX500 bodywork as applied to the 3-axle Volvo Super Olympian

GENERAL DESIGN ISSUES

- × **Bus manufacturers** have to have consideration for some **general issues common to body, chassis or integral builders.**
- × **Maximum weight (laden and unladen)**
- × **Stability - often a tilt test pass is required**
- × **Maximum dimensions - length and width restrictions may apply**
- × **Fuel consumption**
- × **Emissions standards**
- × **Accessibility**
- × In the 1990s onwards, some bus manufacturers have moved towards making **transit bus** interiors more comparable to private cars, to encourage **public transport** ridership.
- × **Other additions** have seen **multimedia** and **passenger information systems**, and **CCTV systems**.
- × **With these developments, bus designs** have been **increasing in weight**, which is a concern for operators with **the rising price of fuels** in the 2000s (decade).

SPECIALIST BUILDERS

- × **Specialist builders** may also produce bodies for **executive, sleeper bus, tour bus, airport bus** or **school bus** uses, with **special features** for these uses.
- × **Builders** may also adapt standard designs for these uses, and especially for **para transit** use.
- × In **Israel**, due to **terrorist** attacks on buses, general bus builders have developed **armoured buses**, and are investigating **controlled boarding systems**. **Armoured buses** are also used for **prisoner transport**.
- × **Articulated buses**
- × **Several manufacturers and operators** have invested in **articulated bus designs**, and even **bi-articulated buses**, to **increase capacity without using two decks**.



Armoured buses in Israel

IDENTIFICATION

- × The **use of different body and chassis manufacturers** can **mean one bus can have up to four identifying badges** - the **chassis maker and model**, and the **bodywork maker and model**, making **non-expert recognition difficult compared** to the **identification of other vehicles, such as cars**.
- × **Operators** may also **paint over**, or **completely remove badges**.
- × This is further confused in Transport in Malta, where the tradition of local modification has seen the wrong **marques** applied to buses.
- × Several bus companies have changed ownership and name many times, leading to the same bus design receiving many different name badges, most notably **Transbus International**.



An operator livery complementing the bodywork features

- x A further confusion can arise in the case where identical bodywork is applied to different chassis.
- x This is sometimes truly identical, or only different in minor details.
- x Mid-engined chassis designs are often identifiable by a mid mounted radiator and exhaust.
- x Radically different bus company liveries can cause problems in the application of a livery to a specific design.
- x Many operators will apply a corporate design in the same way to any bus, leading to some odd sight lines.
- x Some operators are more sympathetic, and tailor their liveries to the specific lines of each bus body design in use.

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- x Often, a bus builder will embark on a re-body programme, such as the East Lanes Greenway, where an existing chassis receives a new body to extend the usable life of the bus.
- x Sometimes this is done by a manufacturer on a piecemeal basis, leading to odd one-off designs.
- x Sometimes, when a number of buses change hands, or operator requirements change, a bus builder may be required to refit them into the new owners preferred configuration.
- x This can include adding/removing doors, or changing the destination display equipment to or from LEID, dot-matrix, or roller blind types.

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- × **Some operators** will rebuild a buses bodywork after **superficial crash damage**, or a bridge strike, again leading to odd one-off looking buses where the standard bodywork was not available.
- × **Bridge strike buses** are often converted to **open top buses**, or into **single-decker bus**.
- × **Older buses** are often converted to **shunters, tow trucks, tree-lopers, training buses or canteens**.



A rebuilt East Lancs Greenway

OPERATOR CONSIDERATIONS

- × Often, **large operators** with **different types** of **buses** will settle on a **standard bus design for their fleet**, to produce savings in **maintenance and driver training**.
- × **These operators** may **either sell off non-standard types, or consolidate them in one operating location**.
- × **Operators** are **often concerned** with the **ease of replacement of consumable items**, such as **bulbs**, and **easily damaged parts**, such as the **lower panels of the body, or windows**.
- × This is **to maximize the time in service for its buses**, although now **builders will offer whole life servicing contracts**.

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- × **Operators** may also make decisions on a **particular bus type** or **components based on the particular terrain operated in.**
- × **Some hillier areas** may select different **powertrain** options.
- × **Areas with many low-bridges** may have more **single deckers** than **double deckers.**
- × **Operators in humid climates** may select **air-conditioning as standard.**
- × A particular difficulty with **double-deckers** is **trees striking the kerb-side top front corner.**
- × Manufacturers, or operators - post delivery, may fit a **bull bar type** arrangement to protect this part of the bodywork.



An East Lancs Olympus body with a tree protection bull-bar protecting the large upper deck front window
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BUS BODY TYPES

- × **A. High Capacity Buses like**
 - × **i. Double Decker Bus**
 - × **ii. Articulated Bus**
 - × **iii. Double Deck Articulated Bus**

- × **B. Special Purpose Buses like –**
 - × **i. Sleeper Coach**
 - × **ii. School Bus**
 - × **iii. Tourist Bus**
 - × **iv. Prison vehicles**
 - × **v. Vehicles specially designed for the carriage of injured or sick persons (Ambulances)**
 - × **vi. Off road vehicles**
 - × **vii. Vehicle Designed for use by Police, Security and Armed Forces**

MINIBUS BODY

The method of building a minibus is for a second stage manufacturer to build a specific body for fitting to a semi-completed van product.

These can produce a higher seating capacity than simple van conversions.

Often the second stage manufacturer is a bus manufacturer.

In a cutaway type minibus, a large passenger cabin body with a full height access door is fitted to a cutaway van chassis.

In these designs, as with van conversions, the driver and front passenger cabin remains unchanged.



- x In a van-derived minibus, a cabin body is applied to a van chassis encompassing the drivers area.
- x These designs may retain some outward signs of the original van, such as the bonnet and grille.
- x Other designs are visually a complete bus design, and it is merely the chassis underneath that is from the van design.
- x The van derived approach can give the advantage of higher seating capacity or more room for passenger comfort, through a larger cabin area.
- x There is also the advantage of being able to have the drivers seat positioned in a small cubicle, next to the main passenger entrance, allowing the driver to collect fares in a transit bus role.

MINIBUS BODY



Some next generation minibus designs with their origins in the **cutaway chassis body build method**, or the **van conversion method**, have been extended whereby parts of the driver cabin and exterior panels are custom built for the minibus model, further altering the visual appearance of the original van bodywork.



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SINGLE DECKER BUS BODY

A single-decker bus or single-decker is a bus that has a single level. Normally the use of the term **single-decker** refers to a **standard 2 axled rigid bus**, in direct contrast to the use of the term **double-decker bus**, which is essentially a **single decked bus** with an **extra deck and staircase**. These types of **single-deckers** may feature **one or more doors**, and **varying engine positions**.



SINGLE DECKER BUS BODY



SINGLE DECKER BUS BODY

Type I: Vehicles are the **medium** and **high capacity vehicles** **designed** and **constructed** for **urban** and **sub urban transport** with **area** for **standing passengers**, to allow movement of passengers associated with frequent stops and **the low capacity vehicles** which are **designed** and **constructed** for **urban** and **sub urban transport** exclusively for carrying **seated passengers**.

The low capacity vehicles in this type can carry standee passengers if they meet provisions for low capacity standee buses.

Type II: Vehicles are **those designed and constructed** for **inter-urban transport without specified area** for **standing passengers**, but can carry **standing passengers over short distance in the gangway**; unless otherwise prohibited by the State Transport Department.

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Type III: Vehicles are those **designed** and **constructed** for long distance passenger transport, exclusively designed for comfort of seated **passengers** and not intended for carrying standing passengers.

Type IV: Vehicles are those **designed** and **constructed** for **special purpose use** such as the following :-

- × **i. School Bus:** means vehicles **designed** and **constructed** specially for schools, college, and other educational Institutions.
- × **ii. Sleeper Coaches:** means vehicles designed and constructed specially **berth to accommodate sleeping passengers**.
- × **iii. Tourist Bus:** means vehicles **designed** and **constructed** for the purpose of **transportation of passengers as tourists** and may be classified in any one Type of comfort levels.

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Non Deluxe Bus(NDX)

means bus designed for basic minimum comfort level.

Semi Deluxe Bus(SDX)

means a bus designed for a slightly higher comfort level and with provision for ergonomically designed seats.

Deluxe Bus(DLX)

means a bus designed for a high comfort level and individual seats and adjustable seat backs, improved ventilation and pleasing interiors.

A.C. Deluxe Bus(ACX)

means a *Deluxe Bus* which is air conditioned.

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DOUBLE DECK



LEY27 - LEYLAND PD2/12

HIGHBRIDGE
"Farington" Body

A new series of designations was used for the 27ft models beginning with PD2/10 for the 7ft 6in wide and PD2/12 for 8ft wide models continuing with other variations.

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TWO-LEVEL (DOUBLE DECK) COACH

GM Buffalo bus is the slang term for several models of intercity motorcoaches built by the GM Truck and Coach Division of the General Motors Corporation at Pontiac, Michigan, between 1966 and 1980. "Buffalo" buses have a stepped roof in front, and the first three rows of seats are **at different levels**, mounted on **stepped floors** similar to some **theatre seating**.



GM Buffalo

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SPLIT-LEVEL MODEL

- x The GM Buffalo bus models were strongly influenced by the PD-450 1 **Scenicruiser** produced by GM exclusively for Greyhound Lines between 1954 and 1966, in a limited run.
- x The **Scenicruiser** was a **split-level model**, with a **lower level at the front containing the driving console** and 10 seats behind it, and **upper level containing 33 seats**.
- x This also **allowed a baggage compartment underneath the second level**, while providing **360-degree view for the upper level**.
- x A lavatory was located in the rear of the first level.
- x Scenicruisers were equipped with an air-ride suspension utilizing air bags at each wheel, and were air-conditioned.
- x **Later on, model PD-4106, a new design, was incorporated, having air-conditioning powered off the engine, a patented V-drive engine-transmission design, and the 8V71 Detroit diesel motor.**

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- x As **Scenicruisers** became a familiar sight around the United States and in advertising, competing bus companies including members of the National Trailways Bus System sought a vehicle to compete.
- x One of the product designs developed in response to this market demand was the GM Buffalo bus.
- x Unlike the Scenicruiser, these models were available for sale to all operators, and in fact, Greyhound only purchased a few of them; the last GM bus purchased by Greyhound was a 1967 PD4107.
- x Many features, such as the **split-level design** and the **revision introduced in PD-4106** model, were included in the **Buffalo bus**.

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SPLIT-LEVEL MODEL

- * PD-4501 Scenicruiser

Every mile a Magnificent Mile...
every highway a strip of velvet...

when you travel in the amazing new
Scenicruiser.

Here's the finest, most luxurious motor coach ever built, with features of comfort and riding ease never before found in travel... the brilliantly-designed Greyhound Scenicruiser!

Routes are already in service, but look more on their way—and only Greyhound will operate these exceptional coaches—raised-level, panoramic sight-seeing, tasteful appointments, undisturbably smooth operation. (Scenicruiser actually floats on air).

GREYHOUND

SEND FOR YOUR FREE PLEASURE MAP OF AMERICA WITH TOUR FACTS

Send to Greyhound
Tour Dept., P.O. Box 1000, St. Louis, Mo. 63103
Name _____
Address _____
City & State _____

Send me special information on a tour to _____
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ARTICULATED BUS

- * **Articulated Vehicle** means a **vehicle** which consists of **two or more rigid sections** which **articulate relative to each other**; the **passenger compartments of each section is interconnected by an articulate section** allowing **free movement of passengers** between them; the **rigid sections are permanently connected** and **can only be separated by an operation involving facilities** which are normally found in a work shop.

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ARTICULATED BUS

Articulated buses are buses of a type with an increased passenger capacity.

Found almost exclusively in public transportation use,

these buses are approximately **18 m (60 ft) long,**
while regular buses are **11 to 14 m (35-45 ft) long.**



This type of bus is also known as

accordion bus, harmonica bus, jointed bus, or bendy bus,

all because of the shape of the bellow and

the fact that the design of

the **turntable joint allows for sharp turns.**

To make them nimble enough to

safely navigate streets at their increased length,

they are **fitted with an extra axle (set of wheels)** and

a joint usually located slightly behind the midpoint of the bus,
behind the second axle.

Some models of articulated buses have a steering arrangement on the
rearmost axle which turns **slightly in opposition to the front steering**

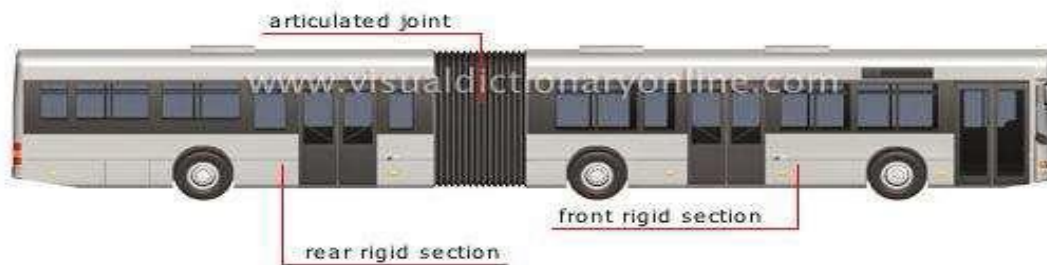
axle, which

allows the vehicle to negotiate turns in a somewhat crab-like fashion,

an arrangement similar to that used on **long hook-and-ladder fire trucks**
operating in **city environments**

- ✘ Articulated buses are buses of a type with an increased passenger capacity.
- ✘ Found almost exclusively in public transportation use, these buses are approximately 18 m (60 ft) long, while regular buses are 11 to 14 m (35-45 ft) long.
- ✘ This type of bus is also known as accordion bus, harmonica bus, jointed bus, or bendy bus, all because of the shape of the bellow and the fact that the design of the turntable joint allows for sharp turns.
- ✘ To make them nimble enough to safely navigate streets at their increased length, they are fitted with an extra axle (set of wheels) and a joint usually located slightly behind the midpoint of the bus, behind the second axle.
- ✘ Some models of articulated buses have a steering arrangement on the rearmost axle which turns slightly in opposition to the front steering axle, which allows the vehicle to negotiate turns in a somewhat crab-like fashion, an arrangement similar to that used on long hook-and-ladder fire trucks operating in city environments

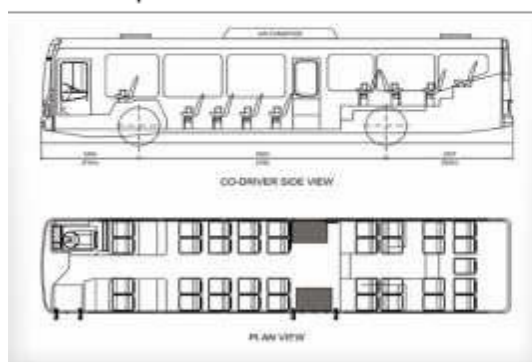
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BUS BODY LAY OUT

The Tata Star bus comes with an assurance of safety and comfort and is the perfect choice for travelers and operators at the same time.

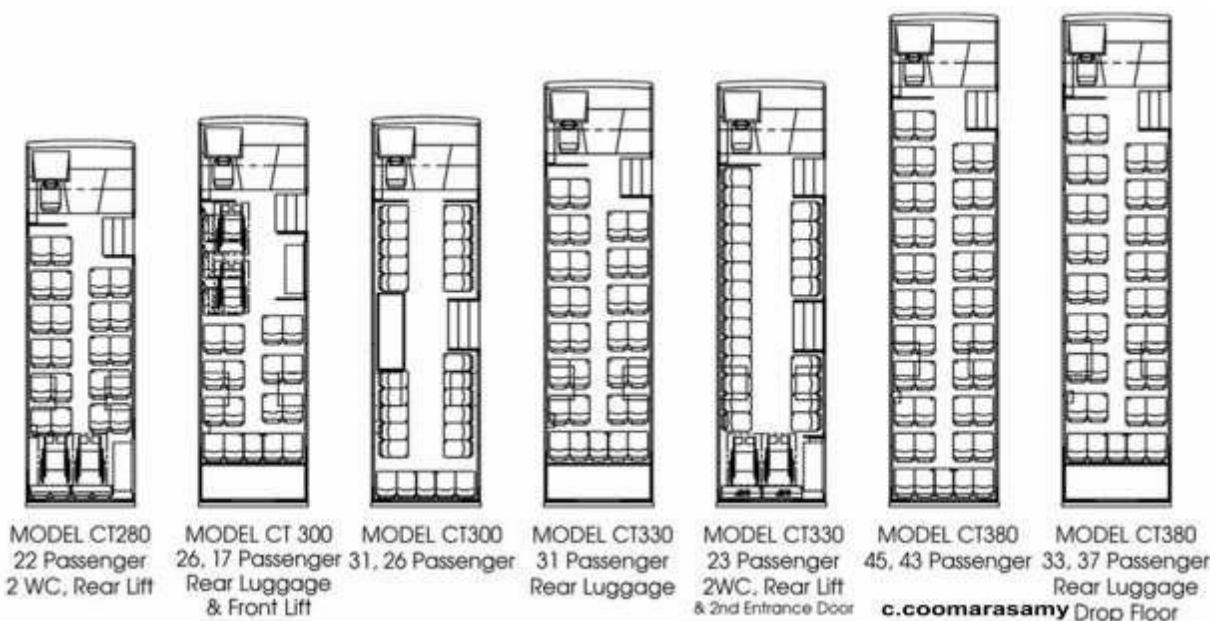
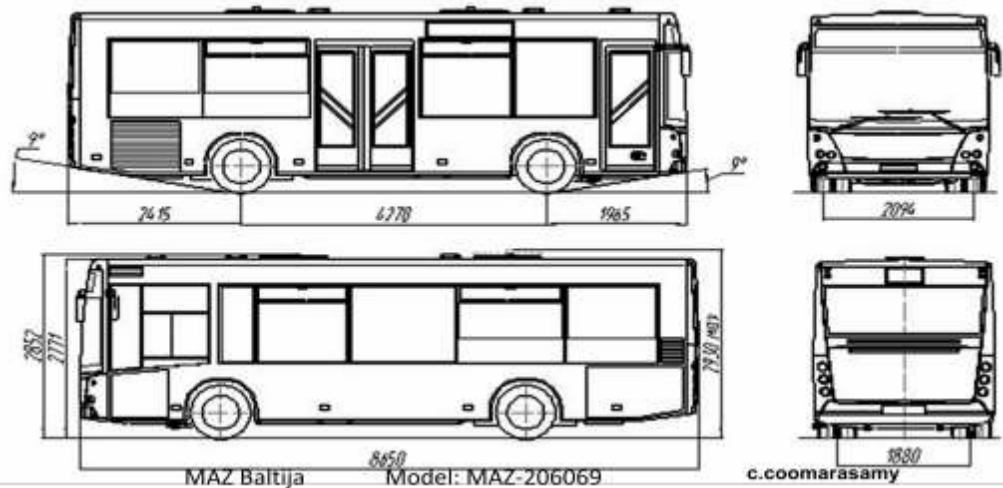
Its superior performance has the stamp of excellence from Tata Marcopolo Motors Ltd.

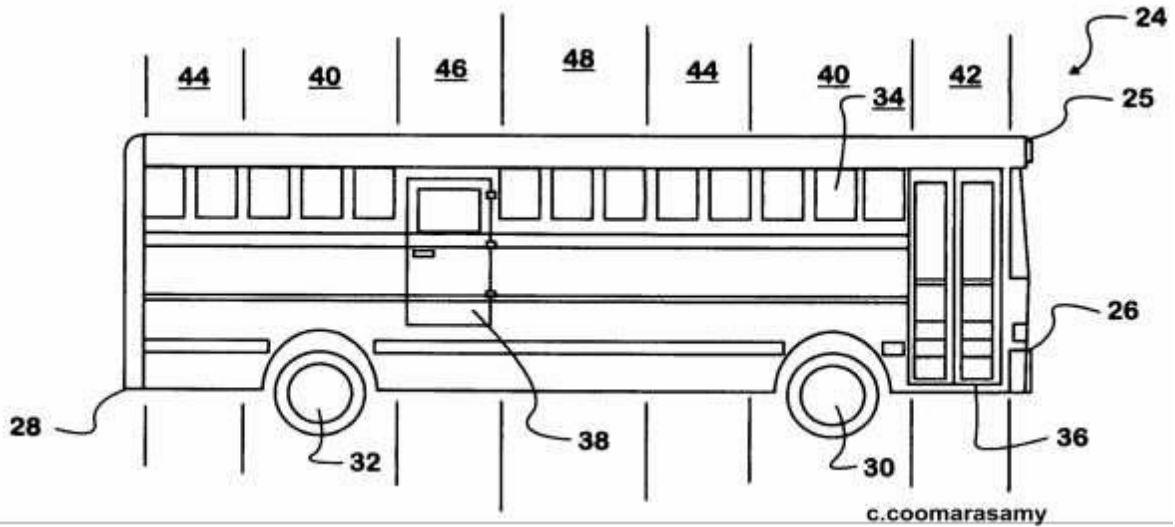


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Low entry RE bus on LPO 1624
BS IV, Diesel

The Tata Starbus comes with an assurance of safety and comfort and is the perfect choice for travelers and operators at the same time. Its superior performance has the stamp of excellence from Tata Marcopolo Motors Ltd.





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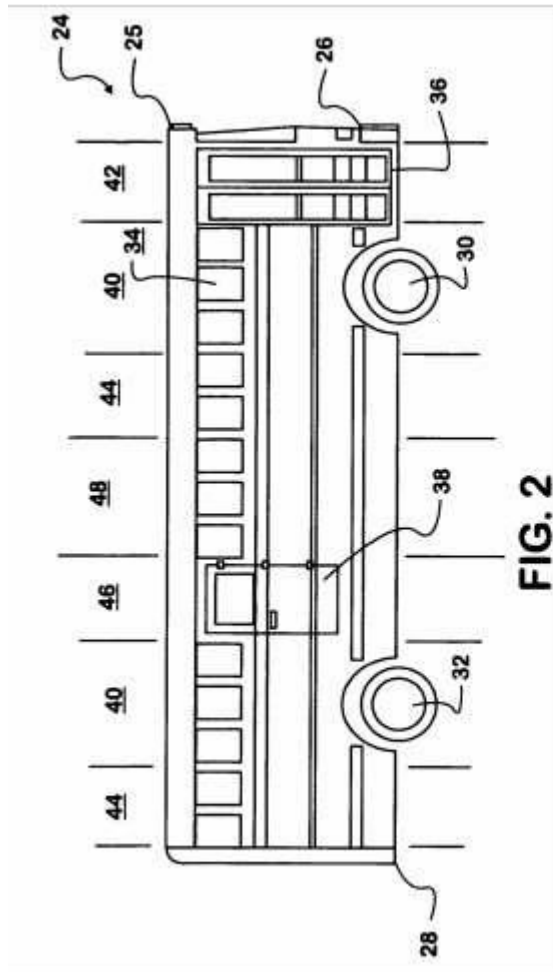
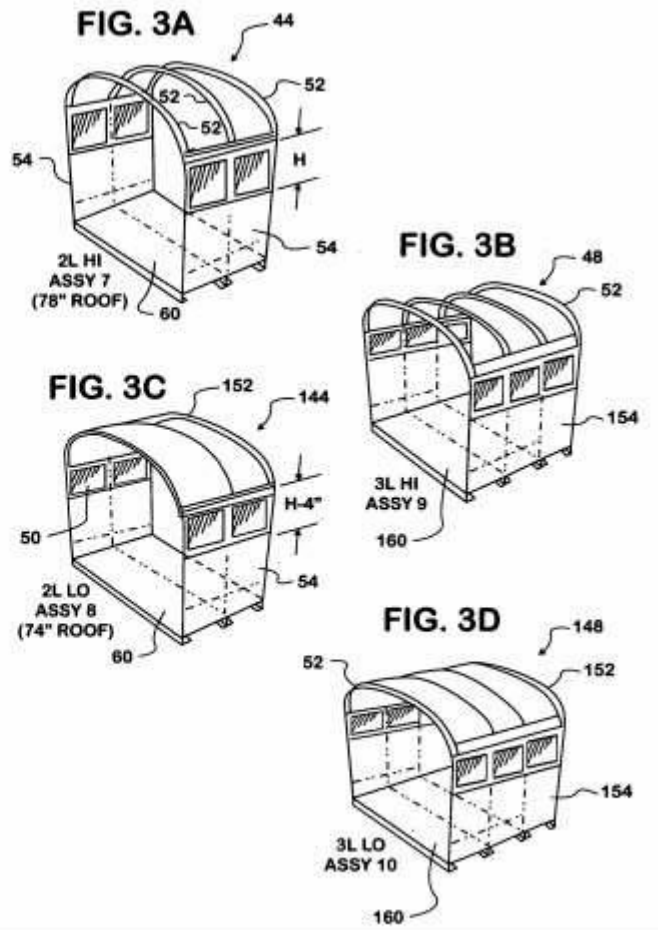
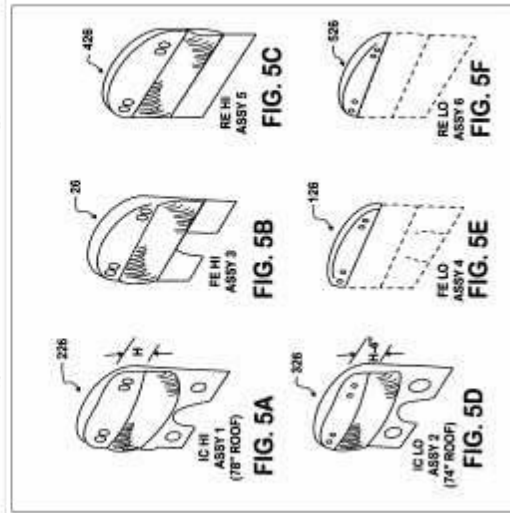
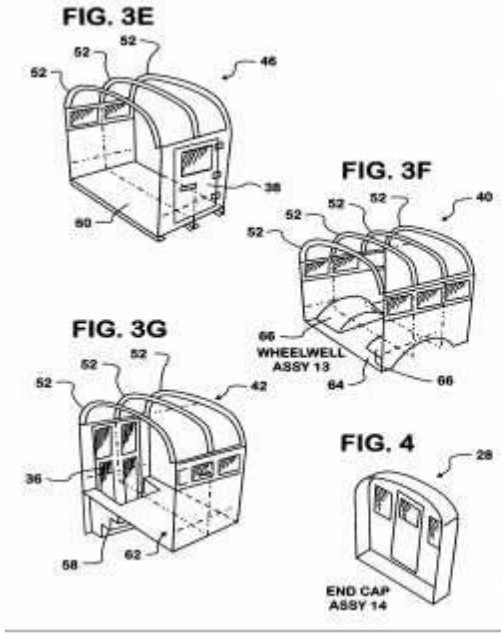


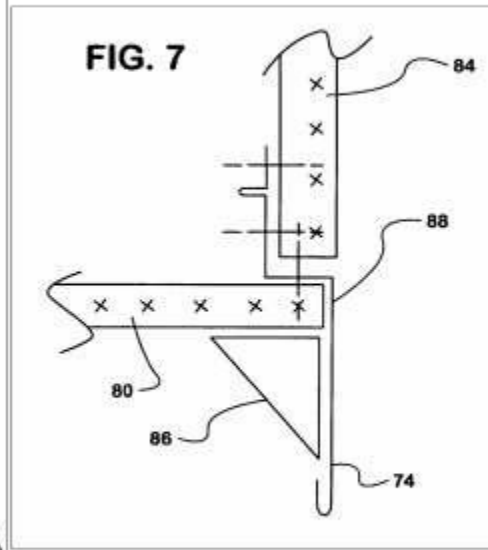
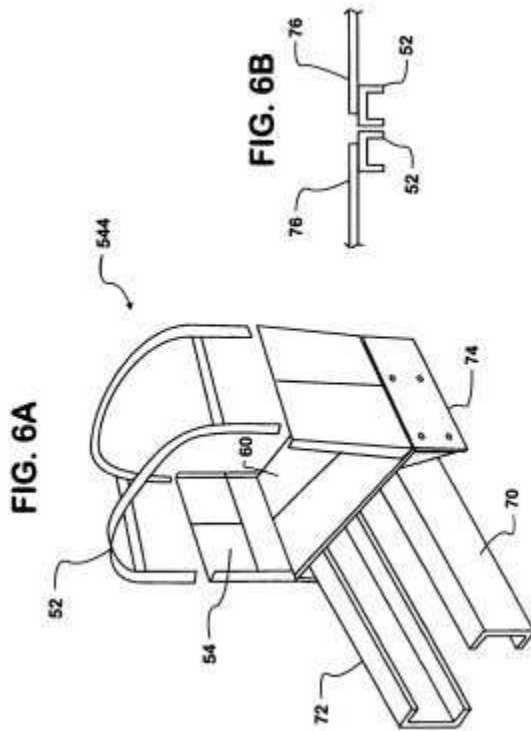
FIG. 2



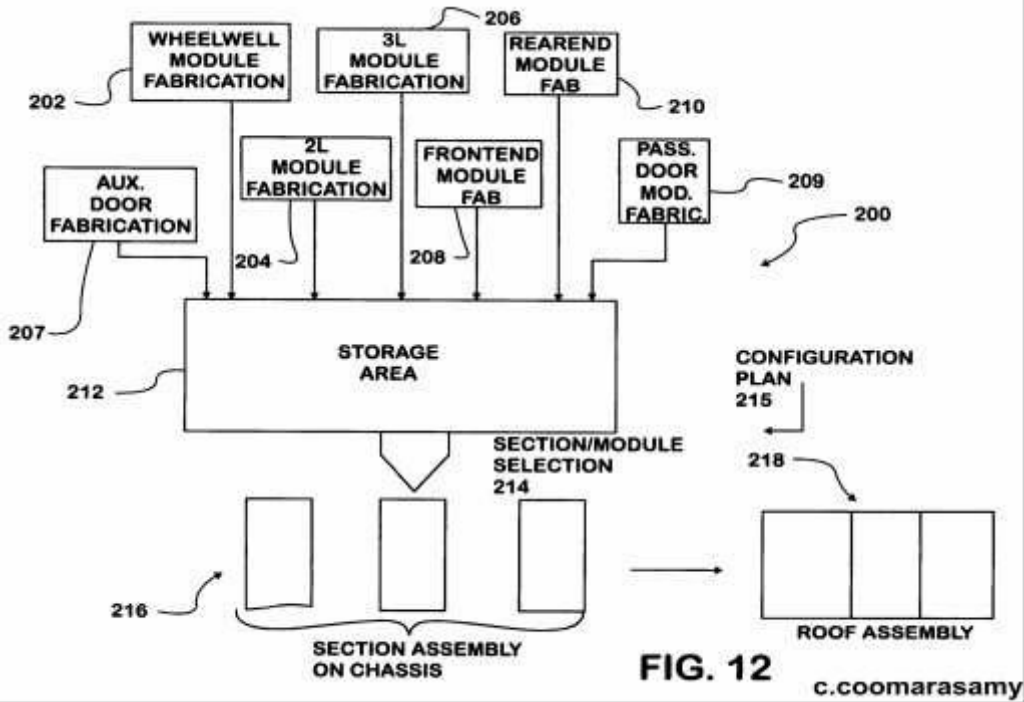
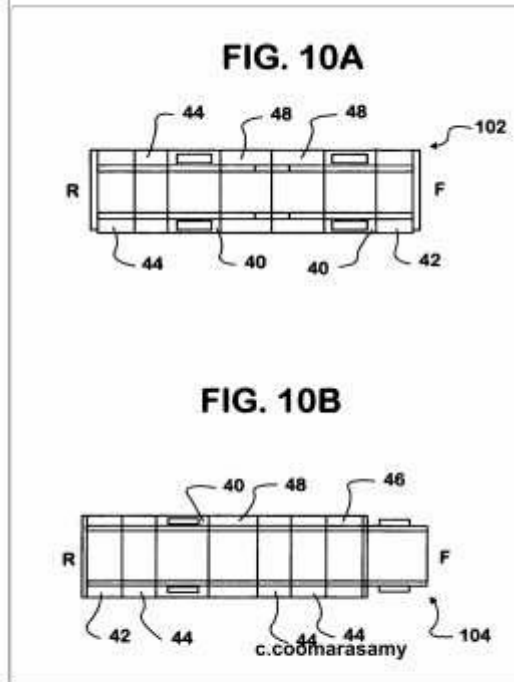
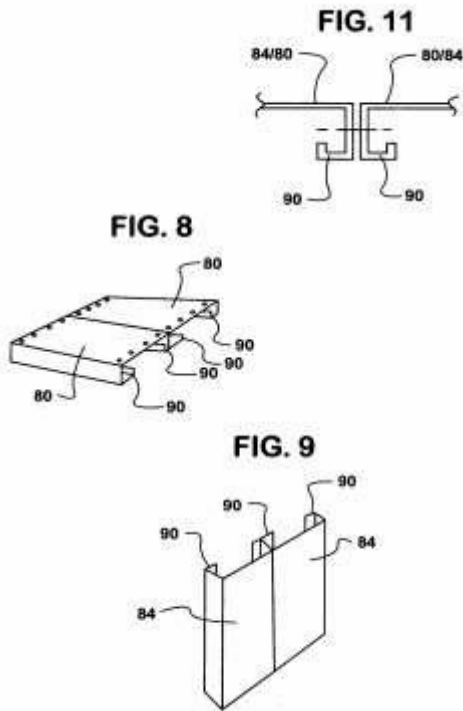
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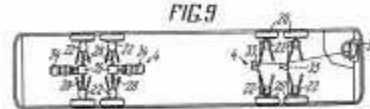
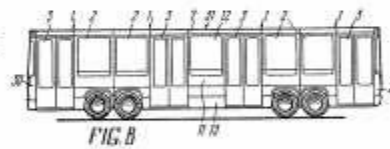
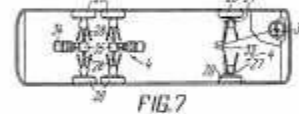
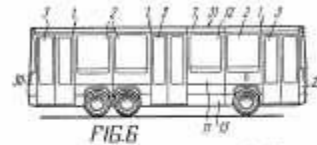
Module element of city bus or like vehicle and bus assembled on the basis of such module elements
US 4469369 A

Module element of city bus or like vehicle and bus assembled on the basis of such module elements
US 4469369 A

Abstract

A module element (1) comprises a transverse window section (2) of the body, open at the ends thereof, a chassis unit (4) including a pair of wheels (20) disposed under a window (12) and connected to the window section (2) by means of a suspension (21), and a transverse door section (3) of the body, open at the ends thereof, and butt-jointed with the window section (2).

U.S. Patent Sep. 4, 1984 Sheet 2 of 2 4,469,369



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A bus assembled on the basis of the module elements (1) comprises an intermediate body section (31) disposed between the module elements (1) and corresponding in the dimensions thereof to one of the sections (2 or 3) incorporated into the module element (1).

The module elements (1) and the intermediate section (31) disposed there between are located between front and rear elements (29 and 30) of the body.

The buses of the same standard size series differ in terms of the number of included module elements (1).

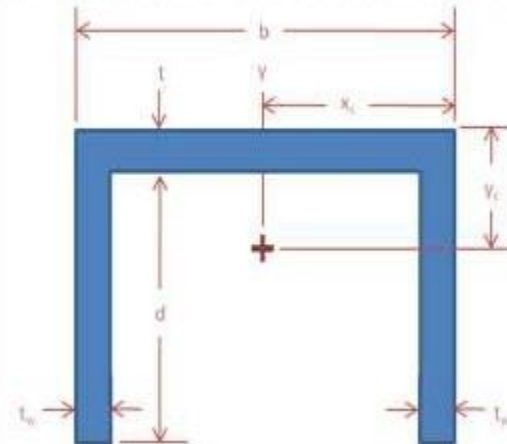
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Frame are made of following sections :

- Channel sections
- Box sections
- Tubular sections

Note- Channel section good in bending, tubular in torsion & box in bending & torsion.

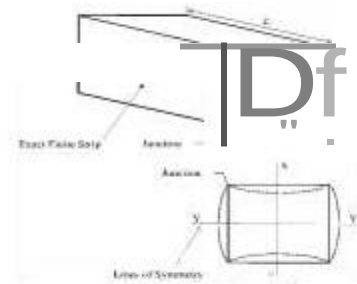
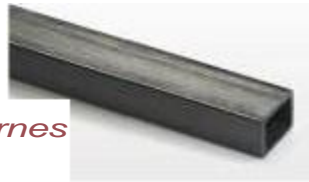
•Channel sections



Used in long section of the frame

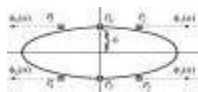
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•Box sections



•Used in short members of frames

•Tubular sections



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TL1bu/ar section is used t?ese days in t?ree wheelers scooters pick-ups.

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Types of Chassis frame:

- **Conventional Frame**
- **Integral Frame**
- **Semi Integral frame**

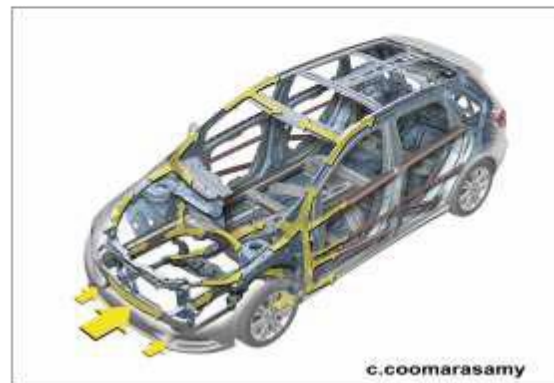
Conventional Frame:

- *It is also known as non load carrying frame. Here loads on the vehicles are transferred to the suspensions by frame.*
- *This type of frame is not suited to resist torsion.*



Semi Integral Frame:

- *In this type of frame load is transferred to the body structure also.*
- *This Frame however is heavy.*
- *In semi integral frame half frame is fixed in the front end on which engine gear box and front suspension is mounted.*
- *This type of frame is used in some of the European & American cars*



Integral Frame:

- *In this type of construction there is no frame and all assembly units are attached to the body.*
- *The chassis , floor and body are assembled by from a large number of mild steel pressings.*
- *This is the modern form of construction for almost all cars and lighter commercial vehicles.*

Some of important Chassis are:

- Ladder Frame
- Tabular Space Frame
- Monocoque Frame
- ULSAB Monocoque
- Backbone Frame
- Aluminum Space Frame
- Carbon Fibre



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• **Ladder frame:**

- *The ladder frame is the simplest and oldest of all designs.*
- *It consists merely of two symmetrical rails*
- *This design offers good beam resistance because of its continuous rails from front to rear*
- *poor resistance to torsion*

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