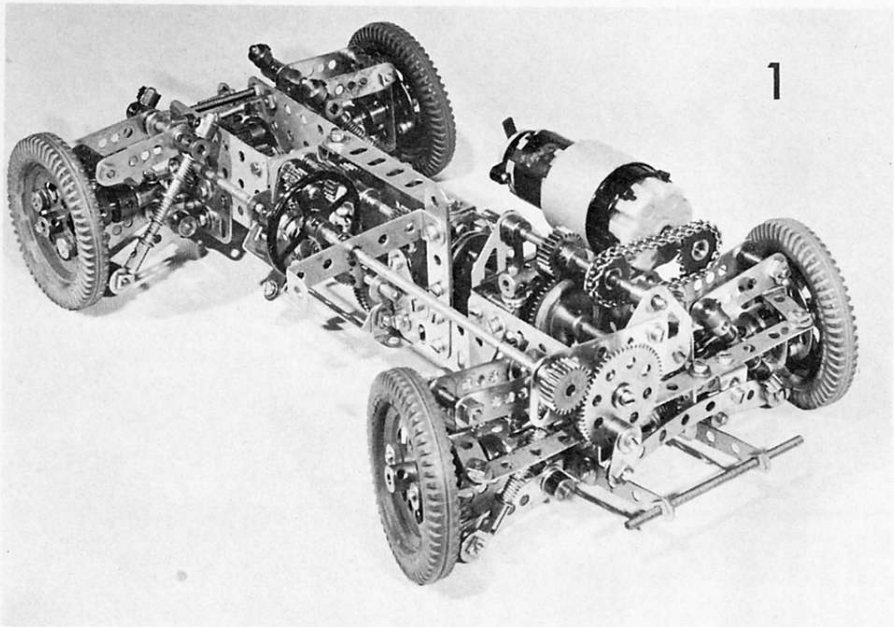



# Cross-country '4x4'

PHOTOGRAPHED AND DESCRIBED BY BERT LOVE

**Fig1 Left: General view of four-wheel-drive chassis showing independent suspension all round. Note coil spring suspension struts.**

Chris Beckett's previous article Bucket on a String [*ME8* 1975 June] demonstrated his design ability as a schoolboy in utilizing Meccano Gears. He has now come up with the compact Cross Country Chassis illustrated in Fig.1. Fitted with four-wheel drive and independent suspension all round, this model really will operate on the ground without the sorry sight of sagging suspension and 'cross-eyed' steering!

The building instructions which follow are based on Christopher's notes. This is a freelance design with spur differentials front and back, flexible drive joints on the front axle, a two speed forward plus reverse gear-box, with the forward gears in syncromesh.

Parallel suspension struts with Compression Spring diagonals are fitted to all four wheels to give all-round independent suspension. High mounting of the power unit is chosen for swamp clearance, and this would be balanced on the opposite side of the chassis by heavy-duty recovery gear and tools stowed in a horizontal compartment over the steering gear. This side of the model is left 'open' for the sake of clarity.

## THE DIFFERENTIALS

Construction of the spur gear differentials is the same for both axles, the crown wheel being a 60-tooth Gear in each case, and these can be seen quite clearly in the various illustrations. Two Long Threaded Pins are bolted to these Gears, and each Pin carries two Washers, a 19-tooth Pinion, another Washer and a Collar. Six-hole Wheel Discs form the other end of the differential cages, and the Threaded Pins engage two of the holes.

A pair of ¾"Bolts in each Wheel Disc carry the intermediate Gears which are also 19-tooth Pinions critically spaced by Washers. Drive to the two half-shafts in each axle is via two more 19-tooth Pinions, but the protruding end of one half-shaft runs in the bore of the Pinion attached to the other half-shaft to provide a central journal. Right angle drive at front and rear is provided by small Contrate Gears driving transverse short Axle Rods carrying 15-tooth Pinions by which, drive to the differential cage is transmitted to the 60-tooth 'crown' wheels.

Restricted length at the rear of the chassis required the use of a Socket Coupling on the Keyway Shaft coming out of the Gearbox to make a short join of the rear Contrate Gear to the gearbox. Sufficient room is available at the front end for a standard Universal Joint before the Contrate Gear which drives the front spur differential.

## THE CHASSIS

Three sections comprise the chassis, namely Rear Axle Box, Gearbox housing, and Front Axle Unit. Starting with the Rear Axle Box, a pair of 3"x1½"Flat Plates are spaced by a 2"Screwed Rod and lock-nuts as shown in Fig.2, and by outrigger bars carrying the rear fender. These outriggers are 3"Strips bolted to the slotted holes of 2"Flat Girders which which are bolted to the lower row of holes in the 3"x1½"Flat Plates. Construction is clear from Fig.3 which shows a close-up of the underside of the rear differential and suspension.

½"x½"Angle Brackets are used to secure the Plate Plates to a 1½"□Flat Plate forming the rear end of the Gearbox housing, but where these Brackets are secured on the underside, the 1½"Plate is extended by a 2½"Strip laid across the bottom three holes. The centre row of holes in the 1½"□Plate is also similarly extended, and this can be seen in Figs.2&3, the purpose of these 2½"Strips being to form securing points for the Gearbox housing.

On the engine side of the chassis, the Rear Axle Box has a 2½"Narrow Strip attached to the centre row of holes in the 3"x1½"Flat Plate, and this Strip extends two holes to the rear, holding Short Threaded Pins and a 1"x½"Angle Bracket forming a gate for the gear lever engagement shaft.

## THE REAR SUSPENSION

Swivel points for the rear suspension arms are ½"x½"Double Brackets mounted on the 3"Flat Plate and 2"Flat Girder for upper and lower points respectively. Collars are used as stand-off spacers as can be seen in Fig.3. Suspension arms at all points on the chassis are 2"Strips, and these pivot on the Double Brackets by means of Rods. On the underside, Collars and Washers secure these Rods, but Fig.2 shows the upper rear suspension pivots which are made from 1½"Rods, but Short Couplings are secured to either end making sure that the transverse plain bore of the Short Couplings is clear to allow the diagonal struts to move freely under load.

Each half-shaft protrudes from the rear axle-box where it receives a Universal Coupling, the second portion of which is secured in a Socket Coupling. Wheel Discs form the hubs and are lock-nutted to the threaded portion of Handrail Supports, but these are first passed through the centre holes of 1½"Double Angle Strips.

Shim washers (Meccano Electrical Brass Washers) should be used between the lock-nuts and DA Strips with a spot of oil to make a smooth-running bearing. Both ends of the DA Strips are tightly bolted to the centre threaded holes of Couplings which ride on 2"Threaded Rods in the upper and lower outboard ends of the 2"supension arms.

Lock-nutted at each end of the Screwed Rods are Rod and Strip Connectors holding the 3"Rods forming the diagonal struts. These struts are each loaded with four Compression Springs separated by Washers, and the upper end of the Rods are capped with Collars, but the Rods themselves move freely in the cross bore of the Short Couplings.

One tapped hole of each Handrail Support is fitted with a Keyway Bolt, and the Socket Coupling is adjusted to make an easy joint on the ball of the Handrail Support. Note: when securing the DA Strips to the Couplings, packing Washers must be used under the boltheads so that the Screwed Rods running through the Couplings are not pinched tight.

## THE GEARBOX HOUSING

Figs. 2&4 show how the Gearbox housing is constructed, the upper reinforcing member being a 3½"Girder secured ny ½"Brackets to the two 1½"□ Plates forming the gearbox ends. On the engine side, two 3½" DA Strips form the gearbox side, and a 3½"Flat Girder bolted to the DA Strips gives added strength.

The front plate of the Gearbox housing has a 2½"Strip across its middle, but the bottom row of holes carries a 2½" Grider, clearly seen in the underside view of Fig.4.

On the gear-shift side of the box, a 3½"DA Strip runs between the two end plates, and is set at an angle of 45° for clearance of the sliding gear-shift rod and its ½"Pulleys used for selector location. Register is provided by a 1"Wiper Arm [Part 531] attached to the third hole of the 3½"DA Strip as shown in Fig.4, the contact tip of the Wiper Arm lodging in the appropriate Pulley groove on gear selection.

Two 1½"Angle Girders are bolted to the outer side of the front Gearbox plate, their longer flanges inwards and their round holes pointing forward to provide securing points for the front axle unit.

## THE GEARBOX

At this stage, the components of the gearbox may be fitted. Fig.4 shows the output shaft which is a Keyway Rod carrying a Universal Joint at its front end, the Rod passing through the bottom centre hole of the Gearbox where it is

**A FOUR-WHEEL-DRIVE OVERLAND CHASSIS WITH INDEPENDENT SUSPENSION AND SYNCHROMESH GEARBOX ★ DESIGNED BY CHRISTOPHER BECKETT**

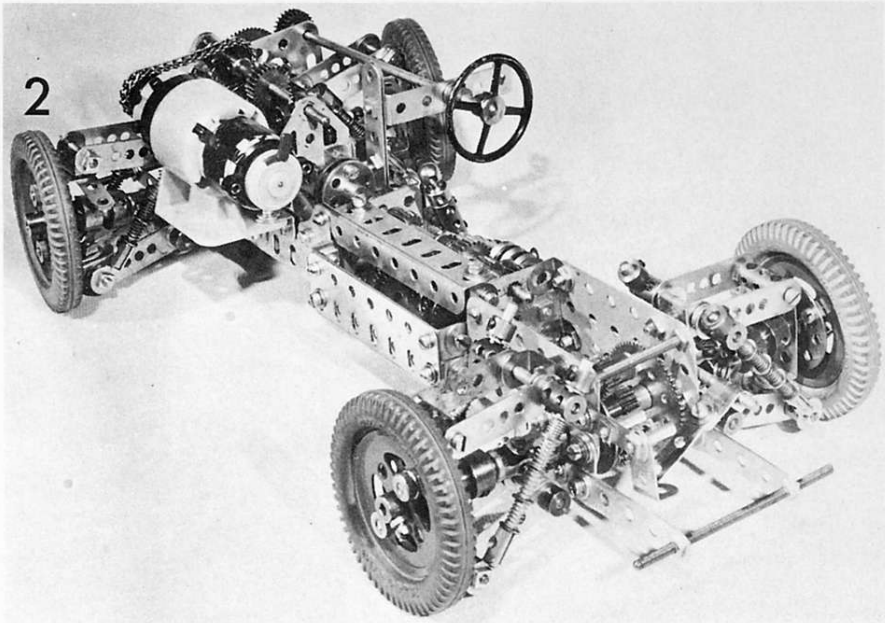



**Fig.2 Right: Rear view of chassis showing box construction and spur-gear differential with flexible drive to the wheel hubs.**

fitted with a Washer and a Compression Spring.

Next comes a 60-tooth Gear and a 1"Flexible Ring in a 1"loose Pulley, followed by another 60-tooth Gear locked into a Socket Coupling with a 50-tooth Gear. A second 1"loose Pulley with Flexible Ring comes next, followed by another 50-tooth Gear, a Compression Spring, a Washer, and one more 60-tooth Gear. The rear Socket Coupling carrying the small Contrate Gear is fixed to the output shaft by an internal Collar.

Journals for the input shaft are the top centre holes of the Gearbox end plates.

A 5"Rod is fitted with a 1"Electrical Bush Wheel [Part 518] that carries two lock-nutted Bolts to engage a similar Bush Wheel from the Motor Drive. If binding occurs at this point, 4BA or 6BA bolts may be substituted.

The input shaft slides for engagement of reverse, so the Bolts in the 1"Bush Wheels must be long enough and free enough to allow about 4mm of travel.

Behind the Bush Wheel, a Collar is fixed to the input shaft followed by a Washer as seen in Fig.4. After inserting the shaft, a Washer, 15-tooth Pinion, Collar, 25-tooth Pinion, 15-tooth Pinion, Compression Spring, and Washer are fitted and fixed in that order, final adjustments being made when the Gearbox selector shaft etc have been fitted.

On the lower (output) shaft of the Gearbox, the rear 60-tooth Gear is fixed to the Keyway Rod, its sole purpose being to act as part of the reversing gear. In constant mesh with this 60-tooth Gear is a 15-tooth Pinion mounted by a ¾" Bolt on a Fishplate, the Fishplate being bolted to the outer hole in the centre line of the rear Gearbox plate. No other gears are fixed on the output shaft, but the Socket Coupling carrying the 60-tooth and 50-tooth Gears is fitted with Keyway Bolts in its slots to give a sliding engagement on the Keyway Rod. The 15-tooth reversing Pinion can be seen just behind the steering wheel in Fig.1.

## THE GEARBOX ACTION

Action of the Gearbox is as follows: The forward 60-tooth Gear and the rear 50-tooth Gear on the Keyway Rod are in constant mesh with their respective Pinions on the input shaft just above them, and these two Gears are revolving in syncromesh all the time that the input shaft is driven. If first gear is required, the gear shift lever moves the Socket Coupling putting the 60-tooth Gear — which is loose on the output shaft — under compression from its spring causing a clutch action between the two 60-tooth Gears and the 1"loose Pulley with Flexible Ring between them.

Further movement of the gear lever moves the 60-tooth Gear that is locked in the Socket Coupling into mesh with the 15-tooth Pinion on the input shaft. Selection of second gear does the same thing for the pair of 50-tooth Gears. In the neutral position, the Socket Coupling Gears are out of mesh or contact with their adjacent Gears.

In the two 2½"Strips running across the centre row of holes in the end plates of the Gearbox housing, the two outer holes are used for the gear shift rod which can be seen just below the steering wheel in Fig.1. This is an 8"Axle Rod, and when pushed through the rear 2½"Strip, it is fitted with the following items. A Collar set as an end stop is spaced slightly from the next Collar and two Washers before the first ½"Loose Pulley. Then two Washers, a ½"Pulley, two Washers and a last ½"Pulley are held in place by a Coupling mounted through its centre cross-bore.

A 1½"Rod is fixed in the bottom hole of the Coupling to run across the lower shaft in the Gearbox as seen in Fig.3. From the top of the Coupling, a 1"Rod actuates the input shaft to engage reverse gear.

## THE GEAR LINKAGE

The actual Gear Lever is a Coupling secured by its lower hole and extended by a Short Pivot Rod into a Handrail Coupling, and the setting of this Coupling acts as the forward end stop for the 8" Gear Shift Rod.

Position and tilt of the Gear Lever are determined by a 'gate' mounted at the rear of the chassis, and this is clear from Fig.2. A 'feeler' for the gate is a 1½" Narrow Strip bolted to a Right Angle Rod and Strip Connector on the end of the gear shift rod. When the 1½"Axle Rod in the Coupling engages with the slot in the Socket Coupling, first and second gears can be obtained by a forward or backward movement of the Gear Lever. To engage reverse, it is necessary to tilt the Gear lever inwards so that the 1½" Axle Rod disengages from the slot of the Socket Coupling, and the 1"Axle Rod in the Coupling bears against the boss-side face of the 25-tooth Pinion on the input shaft. A further rearward pull on the Gear Lever then moves the input shaft and its tail-end 15-tooth Pinion into mesh with the other 15-tooth idler Pinion to change the direction of rotation of the output shaft.

## THE FRONT AXLE AND SUSPENSION

Construction of the Front Axle Unit continues from the two 1½"Girders mounted vertically on the front plate of the Gearbox housing. A pair of 3" Flat Girders are bolted to the bottom two holes in the Girders, slotted holes of the Flat Girders downwards, and the upper part of the joint is strengthened with 1" Corner Brackets as can be seen in Figs.1 and 4.

Two 3"Strips straddle the Flat Girder on the steering side, being mounted vertically three holes along, and sandwiching a 2"Strip to make a strong steering post. A Flanged Bracket may be used here instead of the 2½"DA Strip as a journal for the steering column.

Four holes farther forward, 3"x1½" Flat Plates are bolted to the Flat Girders, and four ½"Angle Brackets are attached inside the Plates at the rear to hold a 1½" □Flat Plate. The upper edge of the 1½"Plate has a Flat Trunnion bolted through to the ½"Brackets and a Double Bent Strip is bolted to the lower edge to carry the 2"Axle Rod driving the front differential. This construction can be seen very clearly in Fig.4. A second Double Bent Strip is bolted behind the Flat Trunnion seen in Fig.2 to carry the clutch shaft from the Motor drive.

A 4"Rod runs through the centre bottom hole of the two Flat Trunnions mounted at either end of the front axle unit, and is fitted, from the front, with a 1"fixed Pulley and Flexible Ring, followed by a 50-tooth Gear fixed in a Socket Coupling, then a Compression Spring, a Washer, and a Collar.

A simple clutch arm is supplied by a Coupling on a 2½"Rod as shown in Figs. 1 & 5, mounted in ½"Angle Brackets on the inside of the 3"x1½"Flat Plate. An Electrical Short Pivot Rod [Part 550] is held in the end hole of the Coupling, and engages the slot of the Socket Coupling just below. A Crank plus a 1½"Strip and ½"Angle Bracket complete the clutch pedal, see Fig.5.

Suspension is similar to that of the back wheels, ½"x½"Double Brackets being stood off by Collars one hole in on the top row of the 3"x1½"Flat Plates. Two 1½" Flat Girders extend the 3"Plates downwards at the front where they carry a pair of 3"Narrow Strips in their slotted holes as front outriggers, spaced by a 3½"Screwed Rod clearly shown in Fig.5. The lower brackets of the suspension arms are also stood off by Collars from these 1½"Flat Girders where the 2"Strips are pivotted on 1"Rods with Collars.

For the upper suspension arms at the front, lock-nutted Bolts form the pivots and also trap Collars by partial insertion into the tapped hole. This allows the diagonal spring struts to ride cleanly through the Collar bores as for the Short Couplings used at the rear end of the chassis. →

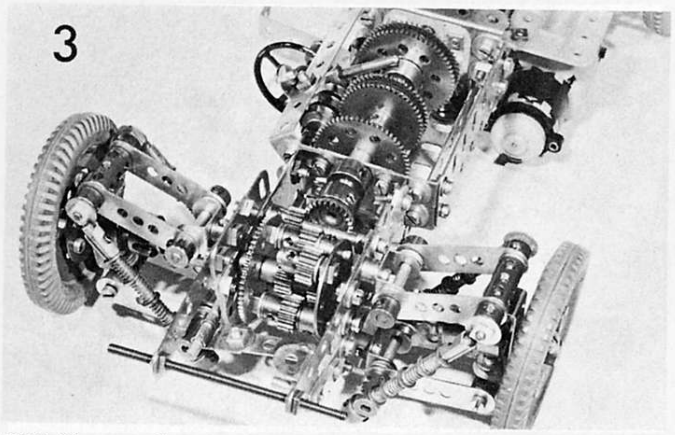



Fig.3 Close-up of rear axle unit showing all-Pinion arrangement in the differential gear, and fixed anchoring points for suspension struts.

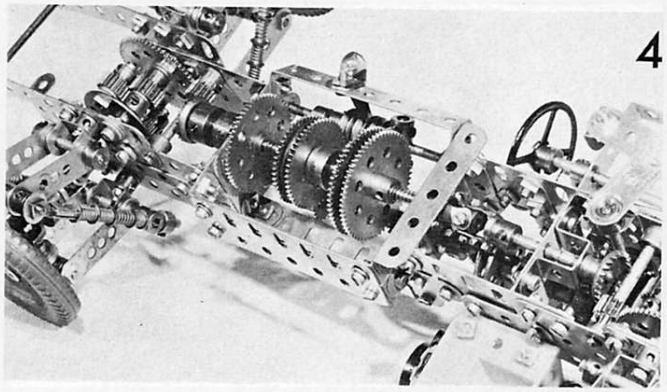



Fig.4 Underneath view of gearbox and transmission drives to identical front and rear differentials. Note clutch pedal lower lever.

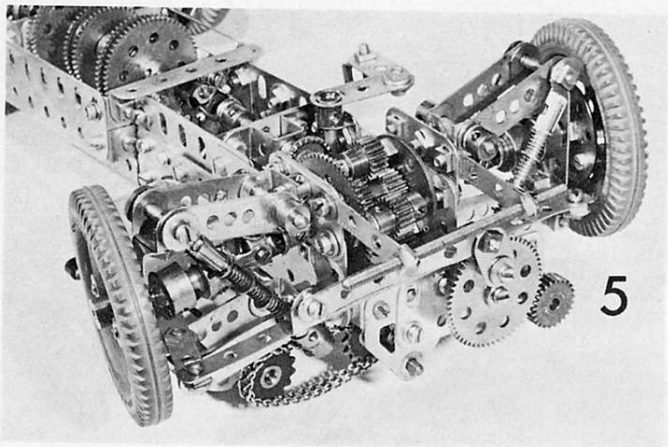



Fig.5 Front axle unit in close-up, showing spring loaded suspension struts and track rod drive arrangements for steering gear.

Fig.6 Below: Top view of front axle unit showing simple motor mounting and arrangement of steering column.

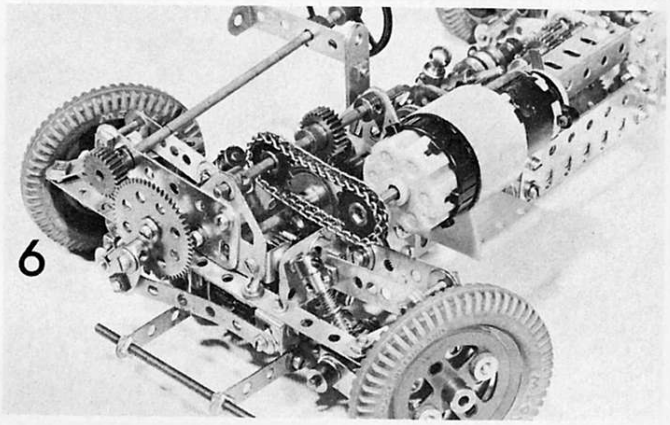
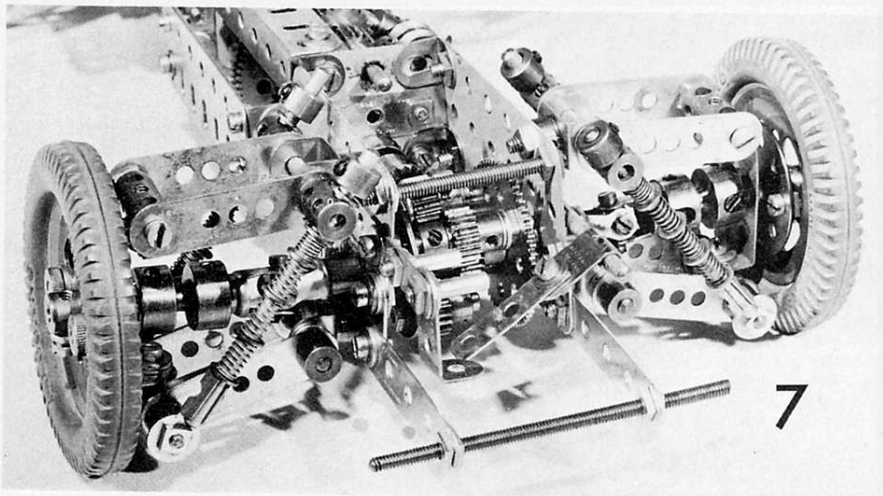



Fig.7 Below: Supplementary closeup of the rear axle assembly showing gear selector 'gate', and location of Socket coupling drive.




In the outboard position of the suspension arms, ½"x½"Double Brackets form the journals for the 1½"DA Strips used as king pins for the front hubs. The lower ends of the DA Strips are pivotted by lock-nuts to their brackets, and the upper ends of the DA Strips have 2½"Narrow Strips attached to them in the process of lock-nutting, these strips acting as steering arms.

Long Bolts or Screwed Rods are used to hold the outboard ends of the suspension arms in the Double Brackets, and lock-nuts on these secure the Rod & Strip Connectors for the diagonal spring struts as shown in Figs.5 & 6.

Two 4½"Narrow Strips are overlapped to form the track rod, lock-nutted between the steering arms and driven via a ½"Bracket from 3"Narrow Strip acting as the drag link. This, in turn, is pivotally lock-nutted to a Fishplate stood off from a 57-tooth Gear by a Collar, rigidly attached by a ½" Bolt and Nut, with a Washer under the bolthead (see Figs.1 & 5).

Another ½"Bolt holds the 57-tooth Gear to a 2½"Flat Girder mounted on the Flat Trunnion at the front of the chassis.

A slight rising angle is permitted on the 6"Rod forming the steering column, and the 50-tooth Gear provides some gear reduction to the steering.

## THE MOTOR

Motor mounting can be to the constructor's choice, a 1½"Angle Girder being used in the illustrations. Wheels are attached by Terminal Nuts [Part 542] to Bolts lock-nutted to the Wheel Discs. Wheels and tyres may be doubled-up by using ½"Bolts.

The general arangement is shown in Fig.7 which also gives a good view of the flexible drive to the rear wheels via the Universal Couplings and ball sections of the Handrail Couplings.

CROSS-COUNTRY 4X4 . . . . . PARTS LIST

| | | |
|---|---|---|
| 2 of No 3 | 4 of No 24a | 1 of No 103f |
| 2 of No 4 | 2 of No 24b | 2 of No 103g |
| 3 of No 5 | 3 of No 25 | 2 of No 103h |
| 18 of No 6 | 12 of No 26 | 2 of No 115 |
| 1 of No 6a | 5 of No 26c | 2 of No 115a |
| 1 of No 9b | 3 of No 27 | 33 of No 120b |
| 1 of No 9d | 2 of No 27a | 2 of No 126a |
| 3 of No 9f | 4 of No 27d | 2 of No 133a |
| 2 of No 10 | 2 of No 29 | 4 of No 136 |
| 12 of No 11 | 100 of No 37 | 1 of No 136a |
| 14 of No 12 | 2 of No 45 | 5 of No 140 |
| 1 of No 12a | 5 of No 48 | 4 of No 142a |
| 1 of No 12b | 1 of No 48a | 3 of No 155 |
| 1 of No 13a | 3 of No 48b | 7 of No 171 |
| 1 of No 14a | 1 of No 62 | 1 of No 185 |
| 1 of No 15 | 1 of No 63 | 8 of No 212 |
| 1 of No 15a | 45 of No 59 | 1 of No 212a |
| 2 of No 15b | 4 of No 63d | 1 of No 230 |
| 5 of No 16a | 4 of No 73 | 1 of No 231 |
| 4 of No 16b | 3 of No 74 | 2 of No 235 |
| 2 of No 17 | 2 of No 80a | 3 of No 235a |
| 11 of No 18a | 2 of No 82 | 2 of No 235b |
| 1 of No 18b | 3 of No 81 | 2 of No 235d |
| 4 of No 20a | 255mm of 94 | 2 of No 518 |
| 2 of No 22a | 2 of No 96a | 1 of No 531 |
| 1 of No 22 | 1 of No 103d | 8 of No 542 |
| 3 of No 23b | 2 of No 103e | 2 of No 550 |
| 2x6BA nuts & bolts | | 1 x Motor-With-Gearbox |