Meccano Hydraulic Crane

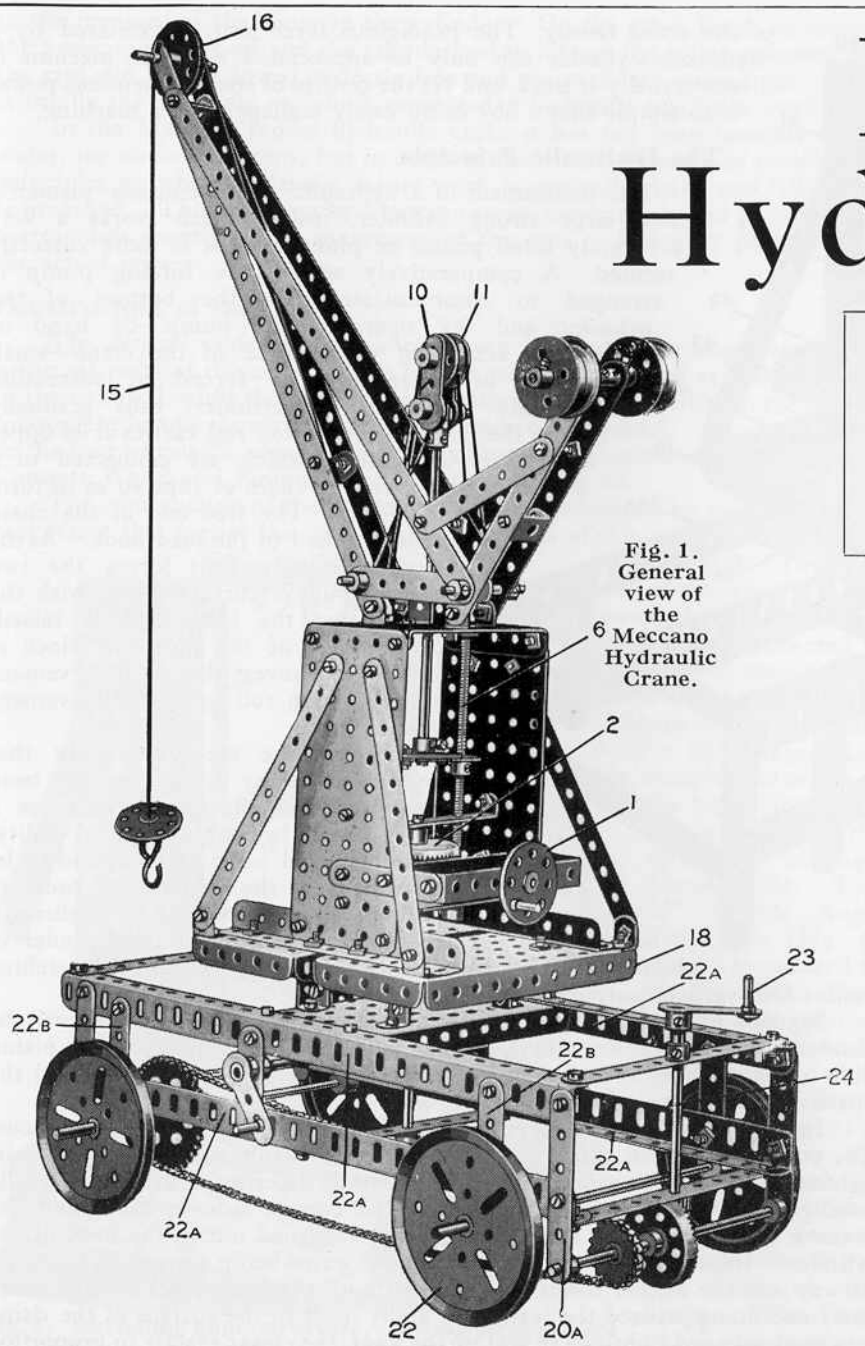

Fig. 1. General view of the Meccano Hydraulic Crane.

SPECIAL FEATURES

Separate control handles for each of the operations, viz., hoisting and lowering of the load, swivelling and travelling. The hydraulic ram is represented realistically by a very powerful screw mechanism that enables loads of great weight to be hoisted easily and smoothly.

THE numerous portable cranes that are to be found scattered here and there in a large works or dockyard form very interesting objects for reproduction in miniature by means of the Meccano system. They cannot compare, of course, with the great derricking cranes so far as lifting capacity is concerned, but they are nevertheless extremely important features of modern engineering works owing to the ease with which they travel from one site to another.

Sometimes at a large works it becomes necessary to carry a load from one department to another, as for instance, a casting from the foundry to the machine shops, and for this purpose there is nothing handier or more suited than a small capacity travelling crane. This may be one of several types, the commonest being the revolving, short jib, steam- or electrically-driven crane. Portable steam cranes have a lifting capacity varying between fairly wide limits, the smallest lifting five tons while the larger ones will lift comfortably anything up to 50 tons. The power is derived usually from a boiler and engine mounted on a revolving superstructure, the boiler generally being of the vertical fire tube type.

Electrically-driven cranes either carry their own batteries from which to obtain the supply of current, or receive the supply from an exterior source, by means of either a flexible cable attached to the frame and trailing along behind, or from rails on which the crane travels. In the latter case the electric circuit is completed through the road wheels, which are in direct electrical communication with the motors contained in the superstructure of the crane, and a conductor rail or overhead wire.

As a rule separate motors are provided for controlling each of the movements of which the crane is capable, the power of these motors ranging from 5 h.p. to 50 h.p. or more.

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Although the steam and electric types are the more popular, there are two other types of portable crane that are equally interesting and efficient. These are pneumatically- and hydraulically-operated cranes.

Portable Pneumatic Cranes

The pneumatic or air-driven crane is seldom used, owing to the special air compressors that are necessary to provide the required power. In some large engineering shops, however, compressed air is employed for a number of purposes, such as working riveting hammers, drilling machines, etc., and in these cases it is no uncommon sight to see one or two compressed-air driven cranes as well.

The necessary power is developed by a small air engine designed especially for high speed. The compressed air enters the cylinders through ports arranged very similarly to those in an ordinary steam engine, the only difference lying in the amount of lap or lead of the valve. As compressed air has no expansion factor such as steam possesses, the air enters the cylinders throughout the whole of the stroke, the pressure thus remaining constant.

These air-driven engines revolve at a great speed and develop considerable power when their size is compared with a steam engine. The pressure of the air supply is usually something like 60 lbs. per square inch.

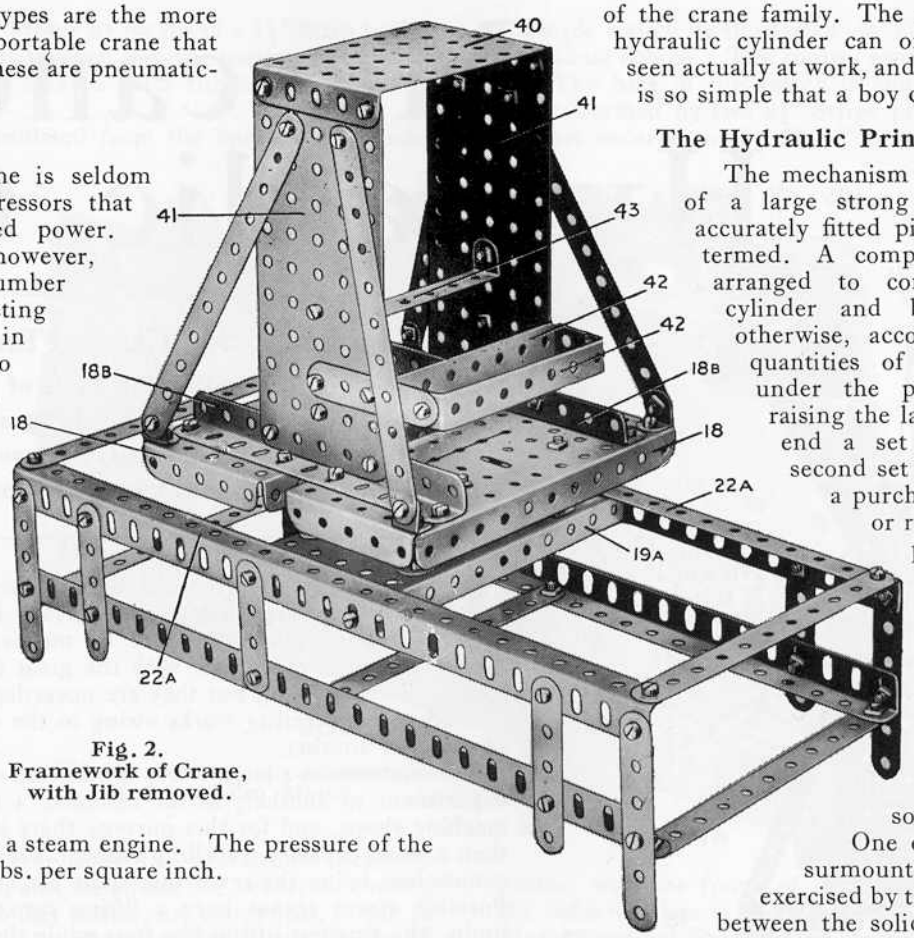

Fig. 2.
Framework of Crane, with Jib removed.

Advantages of Hydraulic Power

The possibility of using water as a source of power had not received much attention until in 1795 Joseph Bramah, the famous engineer, devoted his attention to the matter. He invented a press that was operated by the aid of water, and as soon as the success of this machine became known other engineers directed their activities in the same direction, and it was not long before water power was used to work all kinds of machines. To-day hydraulic machinery may be found in almost every shipyard and engineering works. It is employed to work—amongst other tools—shearing machines that can cut at one stroke steel plates 2″ thick.

Hydraulic machinery is used whenever enormous loads have to be moved. As long ago as 1848 the gigantic tubes of the Britannia Bridge were hoisted into their bed by hydraulic machines. During the construction of this bridge the weight raised by a single machine was over 1,100 tons! While the hydraulic crane may be placed among the smaller cranes so far as structural size is concerned, its capacity for lifting entitles it to a place amongst the giants of the crane family. The prodigious force that is exercised by a hydraulic cylinder can only be appreciated when the machine is seen actually at work, and yet the control of such tremendous power is so simple that a boy could easily manage such a machine.

The Hydraulic Principle

The mechanism of a hydraulic crane consists primarily of a large strong cylinder, inside which works a very accurately fitted piston or plunger, as it is more correctly termed. A comparatively small bore forcing pump is arranged to communicate with the bottom of the cylinder and by operating the pump—by hand or otherwise, according to the size of the crane—small quantities of water may be forced in succession under the piston in the cylinder, thus gradually raising the latter. The piston rod carries at its upper end a set of pulleys which are connected to a second set by means of chain or rope so as to form a purchase block. The free end of the chain or rope is attached to the load hook. As the piston slowly rises, it forces the two sets of pulleys further apart, with the result that the load hook is raised. The object of the purchase block is merely to convert the small movement of the piston rod to a great movement of the load.

It may be mentioned here that only after many difficulties had been overcome did the use of water as a source of power become a practical reality. One of the principal obstacles that had to be surmounted arose from the tremendous pressure exercised by the pump, which forced the water through between the solid piston and the side of the cylinder in which it worked, in such quantities as to render the machine useless for practical purposes.

Bramah himself was completely baffled by this difficulty. It will be observed that the problem was to secure a joint sufficiently free to let the piston slide up through it, and at the same time, so watertight as to withstand the internal force of the pump.

In this dilemma an engineer named Henry Maudsley came to the rescue. The solution came in a flash of genius and the result was Maudsley's self-tightening collar, the action of which a few words description will render easily intelligible. A collar of sound leather, the convex side upwards and the concave downwards, was fitted into the recess turned out in the neck of the cylinder. Immediately on the high pressure water being turned on it forced its way into the leather concavity, "flapped out" the bent edges of the collar; and in so doing, caused the leather to apply itself to the surface of the rising ram so closely and tightly as to seal up the joint, the closer exactly in proportion

to the pressure of the water in the cylinder. On the other hand, so soon as the pressure was let off and the ram desired to return, the collar collapsed and the ram slid gently down, perfectly free and yet perfectly water-tight. Such is briefly the principle on which present-day hydraulic machines work.

In the Meccano model hydraulic crane it has not been possible to use water, for obvious reasons, but in order to illustrate as closely as possible the principles on which hydraulic cranes work, a vertically-rising and falling rod is provided. This is driven by Meccano screw mechanism, and its movement corresponds exactly to the movement of the ram or hydraulic piston rod of the actual crane.

Construction of the Model

The general view (Fig. 1) shows very clearly the arrangement of the principal parts of the crane. The load is raised or lowered at will by means of the handle 1 while the whole superstructure may be swivelled on the base by rotating the handle shown in position at the side of the model. The crane travels on the four wheels 22, which are driven by Sprocket Wheels and Chain through a Contrate Wheel and Pinion operated by the handle 23.

The construction of the model should be commenced by building up the base frame that carries the road wheels. Details of this are shown clearly in Figs. 1 and 2. The main part of the frame is composed of four 12½″ Angle Girders 22a connected at their ends by means of 5½″ Strips and at their sides by 3″ Strips 20a as indicated. A 5½″ × 2½″ Flanged Plate 19a occupies the centre of the top of the frame and is bolted to the upper pair of Angle Girders 22a. Two 2½″ Double Angle Strips 18a (Fig. 6) should be secured to the Plate 19a. They are held in position by means of Angle Brackets.

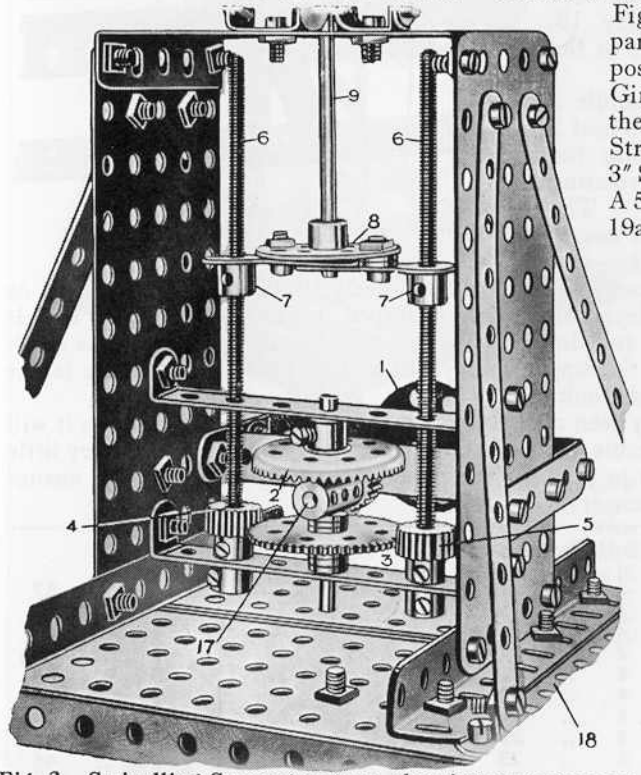

Fig. 3. Swivelling Superstructure, showing arrangement of Mechanism.

The 2½″ Strips 22b (Fig. 1) carry the Axle Rods for the travelling wheels 22 (3″ Pulley Wheels), the Rods passing through the lower end holes of the Strips. The front wheel axle carries a 2″ Sprocket Wheel connected by means of a Sprocket Chain to a 1″ Sprocket Wheel carried on a 6½″ Rod that is journalled in the 3″ Strips 20a bolted to the Angle Girders 22a.

A 1½″ Contrate Wheel mounted on the 6½″ Rod engages a ½″ Pinion on the lower end of the shaft carrying the handle 23 so that when the handle is rotated, movement is transmitted via the Pinion and Contrate Wheel through the Sprocket Chain to the front wheel axle, thus causing the crane to travel either forward or backward according to the direction of rotation of handle 23.

The 6½″ Rod carrying the 1½″ Contrate Wheel is held in position by Collars with set-screws placed on the Rod against the inner sides of the 3″ Strips.

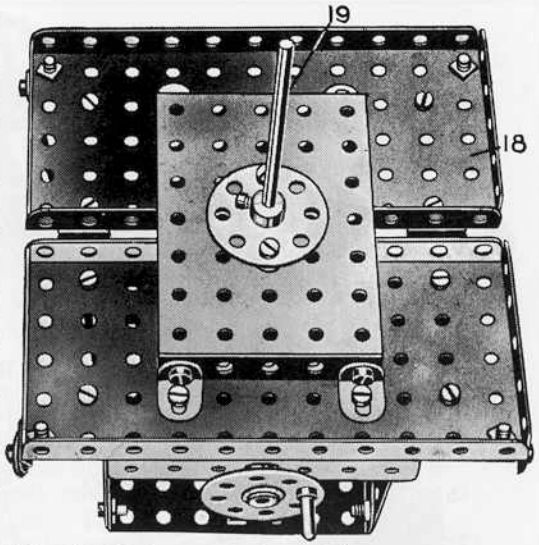

Fig. 4. Underneath view of Superstructure.

Assembling the Superstructure

The framework for the mechanism is carried on a platform 18 (Fig. 2) that pivots about a vertical Rod 19 (Fig. 4) on which is a 57-teeth Gear Wheel. The latter is driven by a Worm carried on the shaft of the handle shown at the side of the base frame (Fig. 1). The Worm and Gear Wheel cannot be seen as they are hidden by the Flanged Plate (19a in Fig. 2).

The constructional details of the crane platform are shown in Fig. 4, which is an underneath view of this part of the model. The platform 18 is built up from two 5½″×2½″ Flanged Plates connected by means of the 5½″ Angle Girders 18b (Fig. 2) the latter being bolted to the upper side of the platform. A Rod 19 (Fig. 4) is fixed in the boss of a Bush Wheel secured to the 3½″×2½″ Flanged Plate that, in turn, is bolted to the underside of the platform 18.

The framework that houses the operating mechanism is shown more clearly in Figs. 2 and 3. Two 5½″×2½″ Flat Plates are bolted to the Angle Girders 18b and are spanned at the top by the 3½″×2½″ Flanged Plate 40. Four 5½″ Strips brace the frame securely to the platform, the lower ends of the Strips being secured to the Plates 18 by Angle Brackets. Two 3½″×½″ Double Angle Strips 43 are secured in the interior of the frame and form journal bearings for the Threaded Rods 6 of the mechanism.

Operating Mechanism

The screw gear and operating mechanism may now be assembled. The load hook is raised or lowered on operation of the hand wheel 1, the arrangement of the gears being as follows.

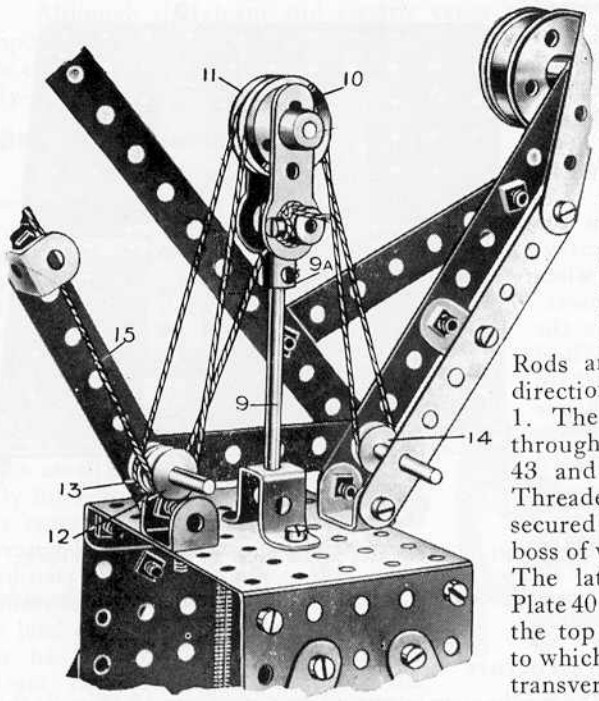

Fig. 5.
Arrangement of Hoisting Gear and Cords.

The Rod of the wheel 1 is journalled in Double Angle Strips 42 (Fig. 2), and carries a ½″ Pinion that gears with a 1½″ Contrate Wheel 2 (Fig. 3), on the Rod of which is a 57-teeth Gear Wheel 3. The latter engages the two ½″ Pinions 4 and 5 secured on the vertical Threaded Rods 6, so that these Rods are rotated in the same direction on rotation of the handle 1. The Threaded Rods 6 pass through the Double Angle Strip 43 and engage the bosses of Threaded Cranks 7 (Fig. 3) secured to a Bush Wheel 8 in the boss of which is fixed a 6″ Rod 9. The latter passes through the Plate 40 (Fig. 2) and is secured at the top in a Coupling 9a (Fig. 5) to which are connected on a 1″ transverse Rod two Cranks that support another 1″ Rod forming a bearing for two 1″ Pulleys 10 and 11.

The inner end of the Rod of the Bush Wheel 1 is journalled in a Coupling 17 (Fig. 3) and is held in position by the wheel 1 on one side of the outer Double Angle Strip 42 and by a Collar and set-screw on the other side. The vertical Rod carrying the Contrate Wheel 2 is free to turn in the centre transverse hole of this Coupling, the latter being held in position by means of two or three Washers.

Two ½″ Pulleys 12 and 13 are mounted loosely on a 2″ Rod at the base of the jib on one side and a single ½″ Pulley 14 on another 2″ Rod at the other side.

Constructing the Jib

Although the construction of the jib is a very simple matter, a little descriptive detail will no doubt be helpful.

The main elements of the jib are formed by four 12½″ Strips spaced by Double Brackets as shown in Figs. 1 and 5. The lower ends of the 12½″ Strips are joined by means of 3″ Strips, while the upper ends incline towards each other and are bolted together as illustrated. A 1½″ Rod passing through the upper end holes of the lower Strips and held in position by Spring Clips, carries a 1½″ Pulley Wheel 16 over which passes the hoisting cord 15.

Four Flanged Wheels are carried on a Rod journalled in the end holes of 5½″ Strips attached to the base of the jib at the rear. These Wheels act as balance weights and help to distribute the strains more evenly about the pivoting centre of the crane.

When completed the jib may be secured to the Plate 40 of the gear frame (Fig. 2) by bolts passed through the lower spacing Double Brackets.

Arrangement of the Hoisting Cord

This model has been designed specially to demonstrate how a very small movement of the operating mechanism can be multiplied greatly by a special arrangement of the hoisting cord. In a real hydraulic crane, the movement or stroke of the piston is quite small—usually only a matter of a few feet—and in order to raise a load through say 15 or 20 feet, it becomes necessary to magnify the movement of the piston by an arrangement on similar lines to that embodied in the model. As already stated, the small vertical movement imparted by the Threaded Rods to the Rod 9 may be likened to that of the hydraulic ram in the actual crane.

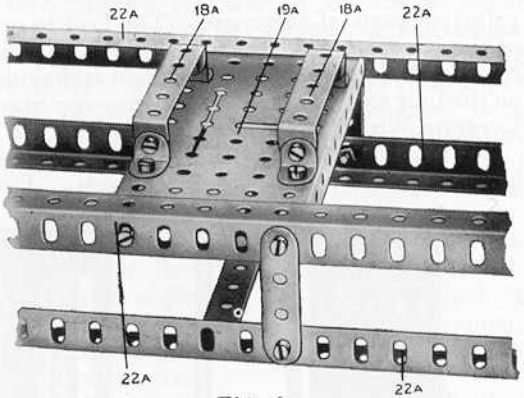

Fig. 6.
Base Framework, showing platform for Superstructure.

The hoisting cord 15 (Fig. 5) passes over the Pulley 16 at the top of the jib, thence round the Pulley 12, over the Pulley 10, round the lower Pulley 14, back round the other Pulley 11 at the top of Rod 9, and then round the small Pulley 13. Finally it is made fast to the Coupling 9a.

By turning the handle 1 (Fig. 3) the Contrate Wheel 2 is rotated, thus driving the Pinions 4 and 5 and rotating the Threaded Rods 6. The movement of the latter causes the Threaded Cranks—and therefore the Rod 9 carrying the Pulley Wheels 10 and 11—to be raised or lowered. As the Pulleys 10 and 11 are forced upward, the cord 15 travels round all the Pulleys, and due to the number of loops of the cord, the small vertical movement of the upper Pulleys 10 and 11 results in a much larger movement of the load hook.

The model having been completed it may be set in operation when it will be found that considerable loads can be lifted by the expenditure of very little effort. It is advisable to place a little oil on the screws and shafts to ensure smooth and easy working.

List of Parts Required to Build the Hydraulic Crane

4	of No.	1	3	of No.	14	2	of No.	27a	1	of No.	57
11	,,	2	3	,,	16	2	,,	28	14	,,	59
2	,,	3	4	,,	17	1	,,	32	4	,,	62
4	,,	4	2	,,	18a	2	,,	35	2	,,	62a
8	,,	5	4	,,	19b	104	,,	37	3	,,	63
2	,,	6	4	,,	20	18	,,	38	2	,,	70
4	,,	8	1	,,	21	1	,,	45	2	,,	80
2	,,	9	2	,,	22a	2	,,	48a	30″	,,	94
5	,,	11	3	,,	23	4	,,	48b	1	,,	95
12	,,	12	4	,,	24	3	,,	52	3	,,	115
2	,,	13a	4	,,	26	2	,,	53			