Twin Cylinder Steam Engine

A Powerful Model of a Stationary Reciprocating Engine

Fitted with Balanced Crankshaft Piston Type Valves and Centrifugal Governor, etc., etc.

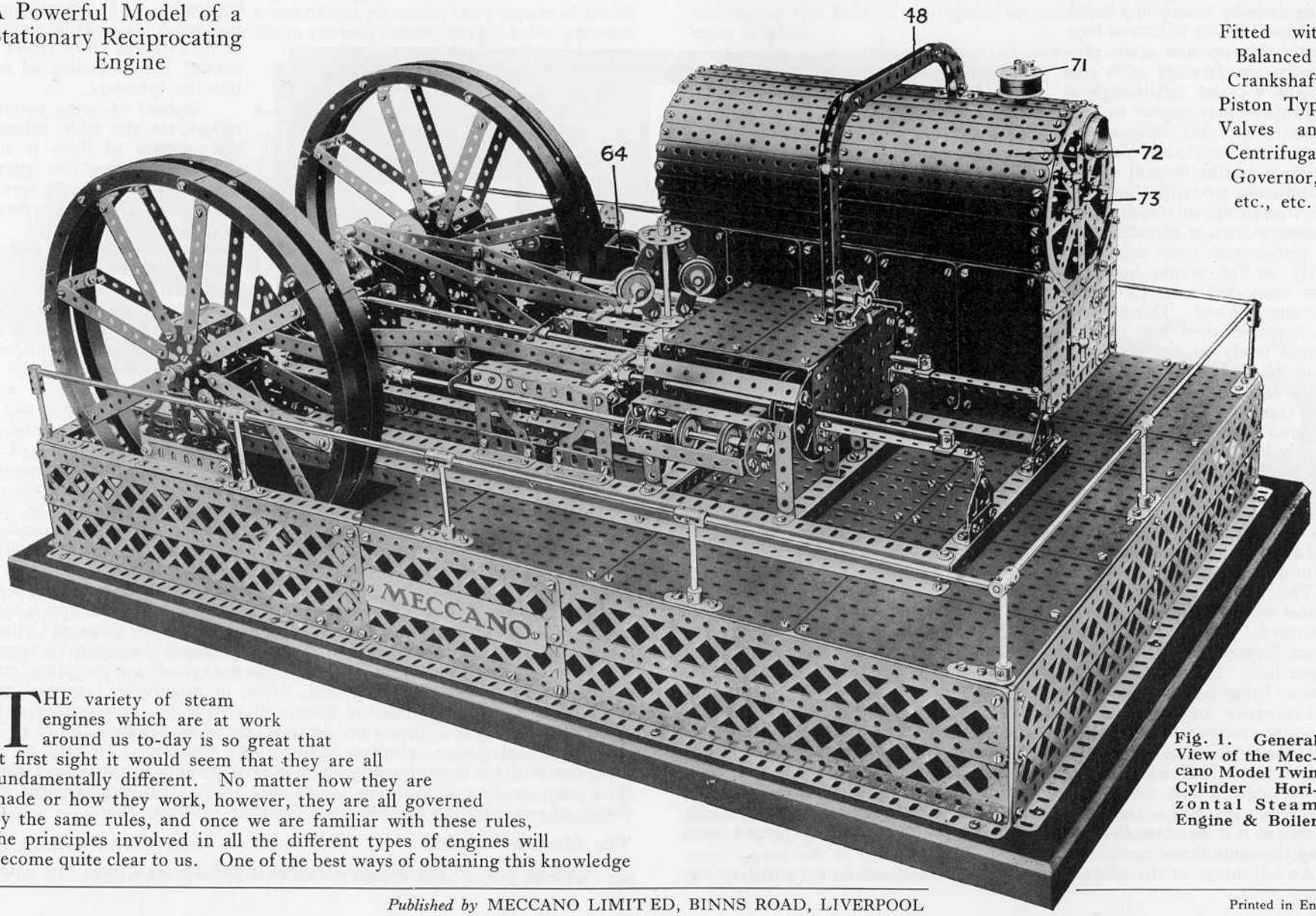

Fig. 1. General View of the Meccano Model Twin Cylinder Horizontal Steam Engine & Boiler

THE variety of steam engines which are at work around us to-day is so great that at first sight it would seem that they are all fundamentally different. No matter how they are made or how they work, however, they are all governed by the same rules, and once we are familiar with these rules, the principles involved in all the different types of engines will become quite clear to us. One of the best ways of obtaining this knowledge

Published by MECCANO LIMITED, BINNS ROAD, LIVERPOOL

Printed in England

of the mechanical principles of a steam engine is to build a Meccano model such as that described in this leaflet.

The majority of steam engines are of the reciprocating type, that is, they comprise pistons which are driven to and fro by the admission of the steam into the cylinders. The to-and-fro motion of the piston rods cannot be utilised very satisfactorily, of course, until it is converted into rotary motion. This is done by means of a crank mechanism. Many Meccano boys are probably cyclists and consequently are familiar with the cranks of a cycle. Although at first glance it may appear to be a vivid stretch of the imagination, the cranks of a cycle and those in the largest marine or mill engine are similar in principle, for they both transform up and down movements into a circular one. The piston rod does not work directly on the crank, however, but is connected to it by means of a connecting rod. This consists of a massive steel bar that is mounted freely on the crank pin and on the end of the piston rod.

In the ordinary way, the crank transmits a very uneven drive, and hence a flywheel must be secured to the crankshaft. The flywheel is a wheel with a heavy rim which, when rotating, smooths out the impulses and makes the crankshaft turn at a constant speed throughout the complete revolution.

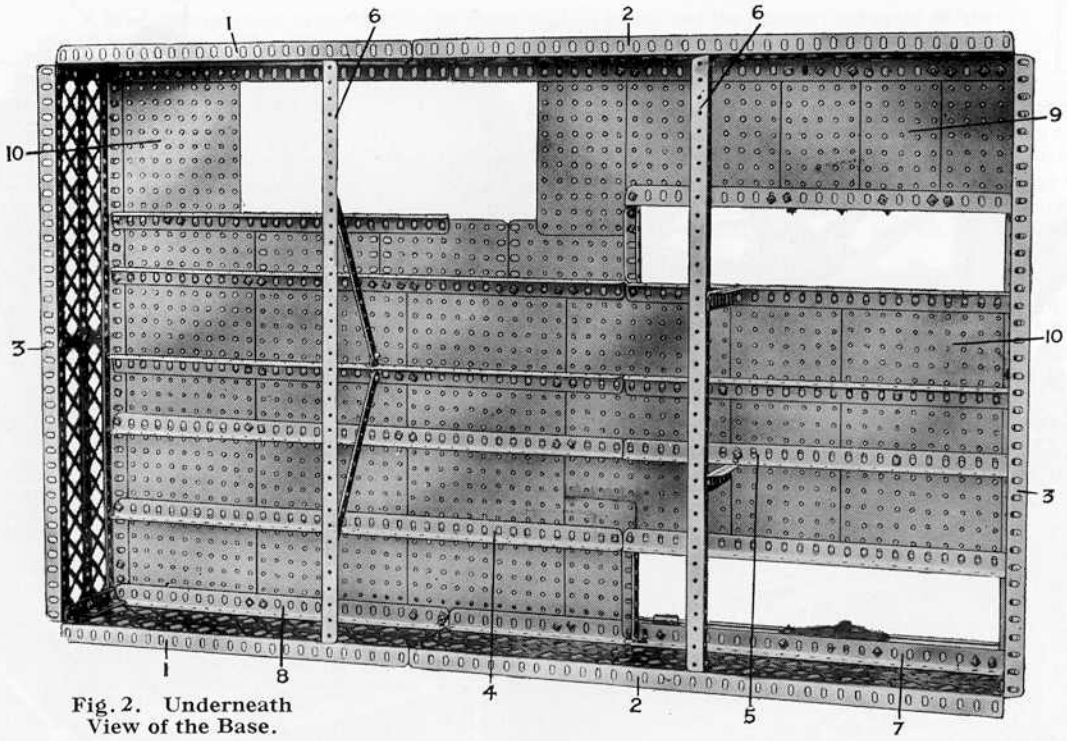

Fig. 2. Underneath View of the Base.

The energy stored in the flywheel also helps the crank over the neutral points, or "dead centres," as they are termed. The dead centres occur twice in each revolution of the crank and are formed when the piston rod, connecting rod, and crank lie in one straight line. Hence there is no turning moment applied to the crank, the tendency being for the crankpin to be sheared off.

Eccentrics are sometimes used in place of cranks to convert rotary motion into reciprocating motion. An eccentric is really a disc of metal that is mounted off its centre on a shaft. It is fitted with a metal surrounding collar that is kept well lubricated so that it can slip easily and smoothly round the periphery of the disc. This collar is attached to a rod termed the eccentric rod. When the disc is rotated the movement of the eccentric rod is exactly the same as if it were attached by a pin to the centre of the disc, or to a crank having the same throw.

An advantage of the eccentric is the fact that it can be mounted on any ordinary shaft without dividing the latter as is necessary if a crank is used. The eccentric, however, can only be used to convert rotary motion into a to-and-fro movement, whereas the action of a crank can be reversed, that is, it can be turned by power applied to it by means of a piston and connecting rod, or it may be used like the eccentric to produce reciprocating motion. The reason for this will be clear to every boy who has handled the Meccano Eccentrics. In steam engines eccentrics are usually employed to operate the slide valves that control the admission of steam into the cylinders.

Instead of using eccentrics to operate the slide valves, an arrangement of links is sometimes used for the purpose. The principal system arranged on this method is known as Walschaerts' Valve Gear. This gear is becoming more and more popular for locomotives and it may interest the reader to know that a realistic Meccano model of it was described and illustrated in a recent issue of the "Meccano Magazine."

Nowadays there is a tendency to use steam at ever increasing pressures and this has led to the adoption of what are known as "compound" engines. This type is the result of efforts to make the fullest possible use of the expansion of the steam by taking it first to one cylinder and allowing it to expand a little and then leading it to secondary and larger cylinders to finish its expansion. The first is termed a High Pressure Cylinder and those used subsequently Low Pressure Cylinders.

If the steam is expanded in three or four stages the engine is termed a triple or quadruple expansion engine. Nowadays all reciprocating marine engines are of either the compound, triple, or quadruple expansion types. If the engine is triple expansion there will usually be three cylinders, high, intermediate, and low pressure. It does not always follow, however, that an engine having four cylinders is quadruple expansion ; it may be triple expansion with the low pressure expansion carried out in two separate cylinders. This compounding of cylinders is the only really great improvement in the design of reciprocating engines since the time of James Watt.

The Meccano Model

Coming now to the Meccano model it will be seen from Fig. 1 that it

comprises two separate cylinders each of which is connected by a piston rod and connecting rod to a common crankshaft. The crankshaft carries eccentrics that are connected to and operate two separate valves of the piston type. Although this engine has two cylinders it is not "compound" as steam is separately admitted to each cylinder and does not exhaust from one to the other as would be the case in a compound engine.

The model incorporates also a centrifugal governor, the purpose of which in the actual engine is to ensure smooth running under varying boiler pressure or unequal loads. The governor consists of a pair of weights attached to pivoted rods, which rotate at a rate depending on the speed of the crankshaft. As the weights rotate they tend to fly outward under the influence of centrifugal force, and in doing so pull down a collar which carries a lever connected with a throttle valve on the main steam pipe.

If the engine speed exceeds a certain limit the movement of the collar commences to close the throttle valve, thus decreasing the amount of steam supplied to the cylinders. On the other hand if the engine slows down the speed of the governor is decreased and the weights fall back, thus opening the throttle and admitting more steam. There are, of course, many other patterns of governors, but the centrifugal type is usually employed on engines of this description.

According to the floor space available, so the engine is erected with its cylinders placed either above the crankshaft (vertical engine) or with the cylinders placed on a level with it. Ships, for example, invariably have vertical engines, whilst in mills and other places, where there is usually a larger amount of floor space in comparison with a ship's engine room, the horizontal type such as the prototype of the Meccano model is preferred.

Construction of the Base

Fig. 2 shows an underneath view of the base, which, as will be seen from the illustration, is strongly constructed from Angle Girders and Plates. The bottom longitudinal Girders each consist of one $18\frac{1}{2}''$ and one $12\frac{1}{2}''$ Angle Girder 1 and 2 and the cross members are $18\frac{1}{2}''$ Girders 3. The four corners are connected together by means of $3\frac{1}{2}''$ Angle Girders, and further cross Girders 6 that are secured by $\frac{1}{2}'' \times \frac{1}{2}''$ Angle Brackets to the main longitudinal Girders 1 and 2 tend to make the structure more rigid. The Flat Plates constituting the floor of the model are attached to "joists" that consist of Angle Girders.

Commencing at the top right-hand corner, it will be seen that five $4\frac{1}{2}'' \times 2\frac{1}{2}''$ Flat Plates 9 are bolted in position, a $5\frac{1}{2}'' \times 3\frac{1}{2}''$ Flat Plate being secured to the end of the left-hand $4\frac{1}{2}'' \times 2\frac{1}{2}''$ Plate. At the other end of the space over which the boiler will eventually be secured two $5\frac{1}{2}'' \times 2\frac{1}{2}''$ Flat Plates are fixed in place. A longitudinal row of four $4\frac{1}{2}'' \times 2\frac{1}{2}''$ Flat Plates are next laid down, and then a similar row of six $5\frac{1}{2}'' \times 3\frac{1}{2}''$ Plates. It should be noted that they are all "butted" together bar one, which is overlapped four holes. A row of $5\frac{1}{2}'' \times 2\frac{1}{2}''$ Flat Plates and then a row of $5\frac{1}{2}'' \times 3\frac{1}{2}''$ are bolted down to the joists, and lastly a row of $5\frac{1}{2}'' \times 3\frac{1}{2}''$ and one $4\frac{1}{2}'' \times 2\frac{1}{2}''$ Plates are secured to the joists 4 and 8. The open spaces left at the bottom and top to accommodate the lower portions of the twin flywheels are termed the "wheel pits."

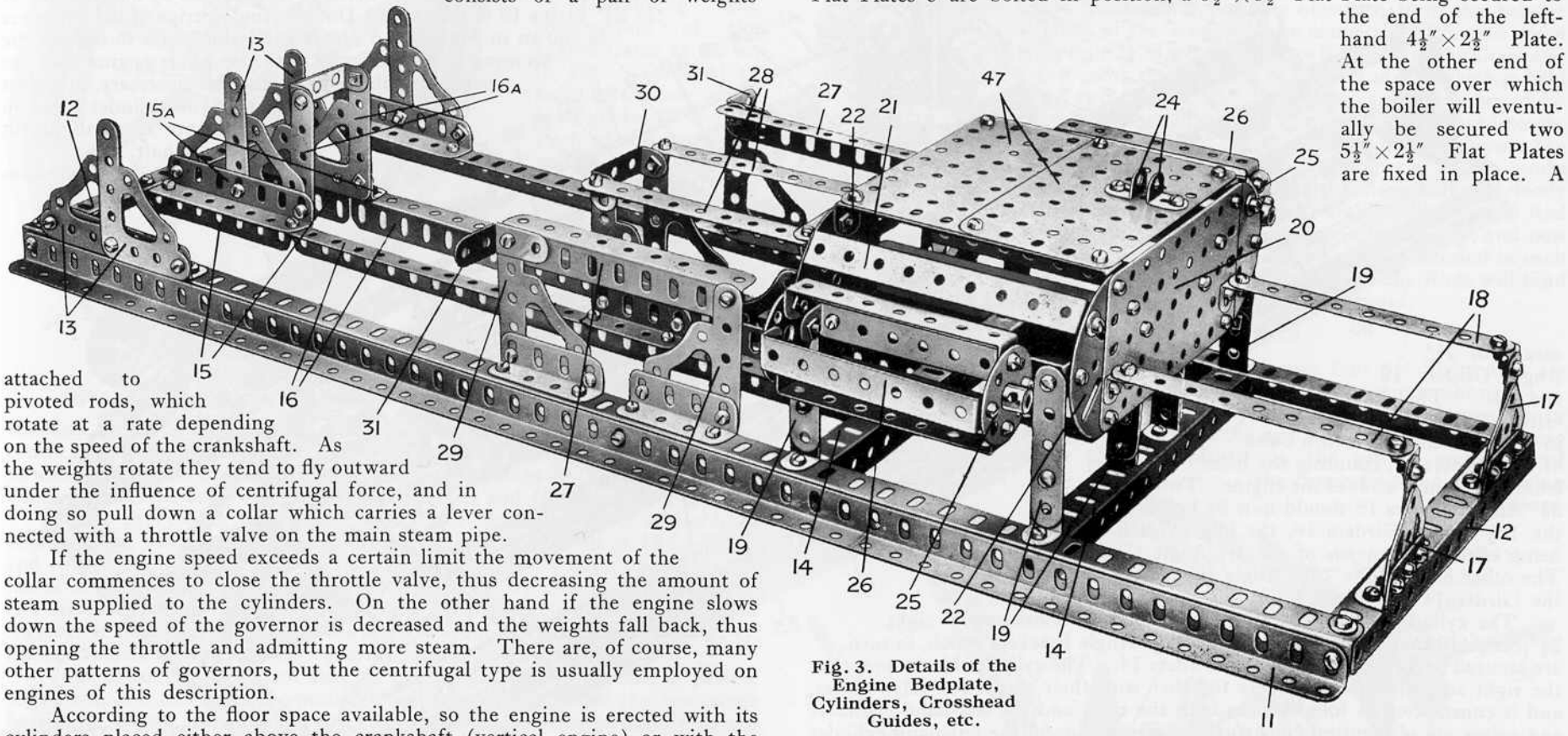

Fig. 3. Details of the Engine Bedplate, Cylinders, Crosshead Guides, etc.

Cylinders and Steam Chests

The engine bedplate, cylinders, guides and crankshaft bearings of the engine are shown clearly in Fig. 3. It will be seen that the sides of the bedplate consist of 24½" Angle Girders 11 bolted in pairs back to back. The two reinforced girders thus formed are connected together by means of 7½" Angle Girders 12 and 14. The Angle Girders 14 should be bolted in the tenth and eighteenth holes of the Girders 11, counting the holes from the cylinder ends of the engine. Two 3½" Angle Girders 15 should now be bolted to the 12½" Angle Girders 16, the join in each case being effected by means of the 3½" Angle Girders 15a. The other ends of the 12½" Angle Girders 16 are bolted to the Girder 14 as indicated.

The cylinder block is supported on columns consisting of eight 2½" Strips 19 that are bolted to eight 1" × ½" Angle Brackets which, in turn, are secured to the transverse Angle Girders 14. The cylinder block comprises the right and left-hand cylinders together with their respective valve chests, and is constructed as follows : As both the right and the left-hand cylinders and valves are of identical construction a description of the left-hand cylinder and valve will suffice for both.

The cylinder proper consists of two Face Plates 22 which are spaced apart by six Double Angle Strips 21. It should be noted that the front end Face Plate has its boss turned outwards while the boss of the rear end Face Plate is turned inside the cylinder. After constructing the cylinder in this manner it is bolted by its near end Face Plate to a 4½" × 2½" Plate 20, the positions of the securing bolts being clearly shown in the photograph.

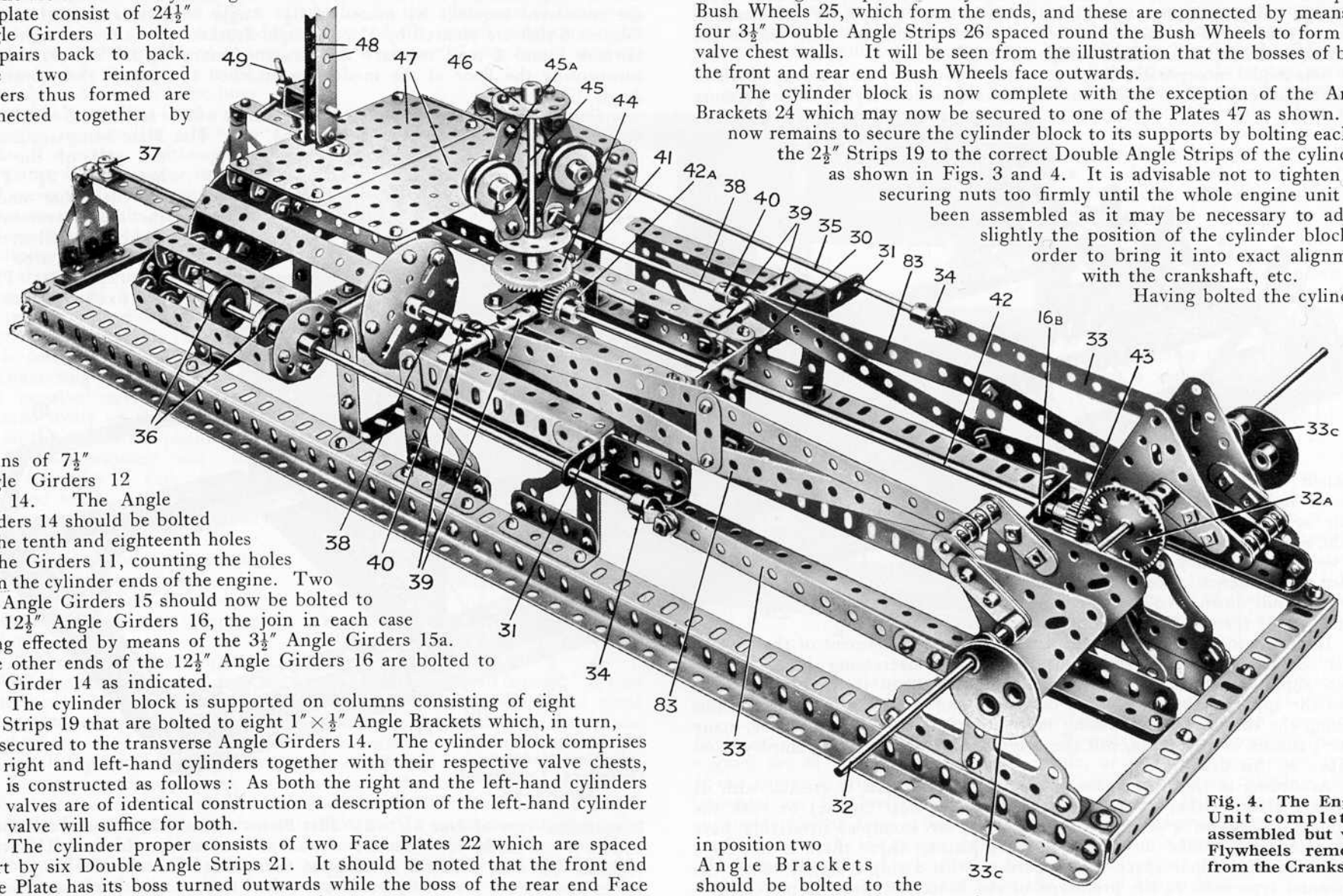

Fig. 4. The Engine Unit completely assembled but with Flywheels removed from the Crankshaft

The top of the steam chest, i.e., the space between the two cylinders, is formed by two 4½" × 2½" Plates 47, overlapped and bolted to the topmost Double Angle Strips of the cylinders. The valve chests 26 each comprise Bush Wheels 25, which form the ends, and these are connected by means of four 3½" Double Angle Strips 26 spaced round the Bush Wheels to form the valve chest walls. It will be seen from the illustration that the bosses of both the front and rear end Bush Wheels face outwards.

The cylinder block is now complete with the exception of the Angle Brackets 24 which may now be secured to one of the Plates 47 as shown. It now remains to secure the cylinder block to its supports by bolting each of the 2½" Strips 19 to the correct Double Angle Strips of the cylinders as shown in Figs. 3 and 4. It is advisable not to tighten the securing nuts too firmly until the whole engine unit has been assembled as it may be necessary to adjust slightly the position of the cylinder block in order to bring it into exact alignment with the crankshaft, etc.

Having bolted the cylinders in position two Angle Brackets should be bolted to the Plate 20, as illustrated. These form supports for one end of two 4½" Strips 18 on which the Eye Pieces 37 (Fig. 4) slide. The other ends of the Strips 18 are bolted to Angle Brackets that are secured to 2" Strips that, in turn, are

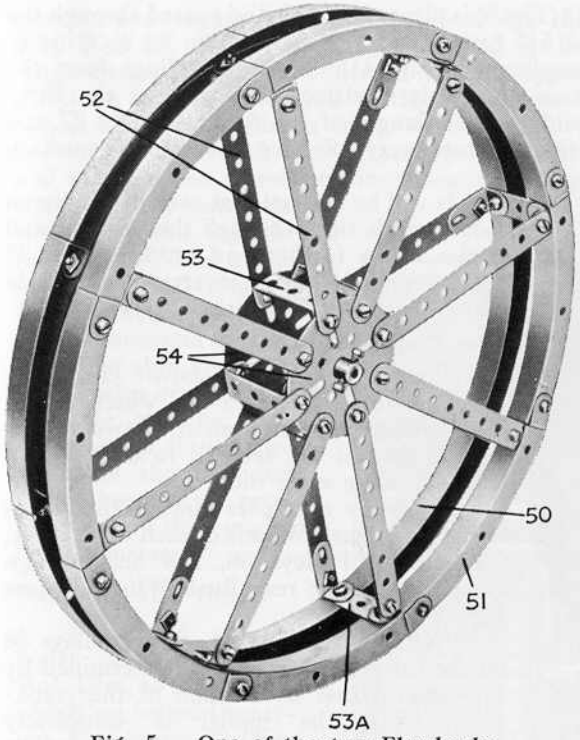

Fig. 5. One of the two Flywheels

bolted to Flat Trunnions 17. These latter are bolted to 1½″ Angle Girders secured to the Angle Girder 12 of the Base-frame.

The Crosshead Guides and Supports

Continuing the construction of the engine frame as shown in Fig. 3, proceed to build up the four crosshead guides 27 and 28. Each of the two outer guides consists of two Architraves 29 bolted to a 4½″ Angle Girder. Two 2″ Angle Girders bolted one to each Architrave provide the means whereby the whole is secured to the bed plate. To each of the outer guides 27 a 1″×1″ Angle Bracket 31 is bolted. These Brackets form supports for the valve Rods 35, as shown in Fig. 4. The two centre guides 28 are connected by a 1½″ Double Angle Strip 30. The crossheads, as will be described later, are formed by Strip Couplings 39 (Fig. 4) the slots of which slide on the flanges of the Angle Girders 27 and 4½″ Strips 28 (Fig. 3).

Before proceeding to assemble any of the mechanism it is advisable to construct the bearings for the crankshaft. These are shown at 13 in Fig. 3 and consist of Architraves bolted back to back in pairs. Each pair of Architraves is secured to the engine frame by means of 3½″ Angle Girders. The two Architraves 16a (Fig. 3) bolted to the 3½″ Angle Girders 15a are joined together at the upper ends by means of a 1½″ Double Angle Strip 16b (Fig. 4), the centre hole of which forms a journal for the Rod 42 (Fig. 4).

It is, of course, important that all bearings in this model are in perfect alignment, and this point is specially important in the case of the crankshaft bearings. Before the several pairs of Architraves are secured rigidly to the bed plate of the engine, it is advisable to pass a rod through the upper holes of all four supports, as these holes will form the crankshaft bearings proper; whilst the rod is in position it will be an easy matter to make slight adjustments in the positions of the supports in order to obtain proper alignment.

Construction of the Crankshaft

As the successful working of the model depends to a large extent on the accurate construction of the crankshaft, particular care should be paid to this important part of the engine.

Two Rods 32 (Fig. 6) each carry at their inner ends a Crank 81, to the arm of which a 1½″ Strip is bolted to add strength to the Cranks. The centre portion of the crankshaft comprises a Rod 32b on which are secured a 1½″ Contrate Wheel 32a and two Collars. The exact position of the Collars on the Rod will be arranged when the crankshaft is placed in its bearings. Each end of the Rod 32b carries a Crank 81a and these Cranks are secured to the Rod at an angle of 90 degrees to each other, as shown in the illustration. They are strengthened with 1½″ Strips in a similar manner to the Cranks 81.

The crank pin "webs", the lower portions of which form the balance weights to counter the effect of the weight of the connecting rods and crank pins, etc., are formed from four 2½″ Triangular Plates 82 bolted to the Cranks 81 and 81a. Each of the two crank pins consists of a 1½″ Rod 80a which is held securely in the bosses of two Cranks 80. The latter are strengthened by means of 1½″ Strips in the manner described above and are secured to the inside faces of the Triangular Plates 82, by the same bolts that secure the Cranks 81 and 81a. It is very important that the set-screws of all the cranks should be screwed home very tightly so as to make the crankshaft a perfectly rigid unit. To ensure reliable working a small flat should be filed on the Rod beneath each grub-screw so that the latter may obtain a better grip, and new style Cranks should be used so that two grub-screws may be inserted in each boss. Great care must be taken in filing the flats, or else the Rods will bind against the grub-screws and become very difficult to remove.

The Connecting Rods and Valve Eccentrics

Each of the two connecting rods 83 comprises four 5½″ Strips that are bolted in pairs end to end and joined together by a 1½″ Strip as shown.

Each connecting rod is connected freely to one of the crank pins 80a of the crankshaft by passing the pin through the end holes of the Strips forming the connecting rod; a Collar is placed on the pin on each side of the connecting rod for spacing purposes.

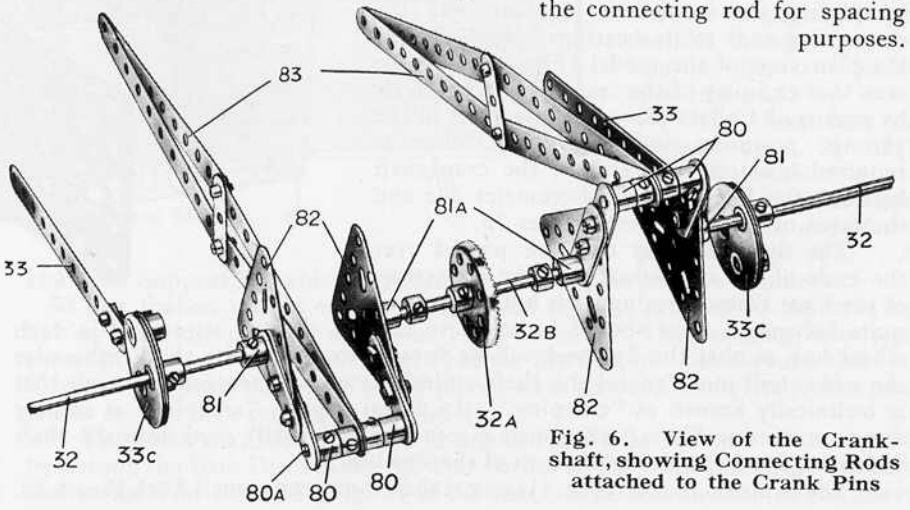

Fig. 6. View of the Crankshaft, showing Connecting Rods attached to the Crank Pins

The Eccentrics 33c control the movement of the slide valves to which they are connected as shown in the view of the completed model (Fig. 1). As the Eccentrics cannot be connected up until the model is finally assembled they may be passed over the Rods 32, the final adjustment of their position being left until all the other working parts have been secured in place.

Construction of the Flywheels

Two flywheels are required. Both are of similar construction and one of them is shown in detail in Fig. 5.

The hub of the wheel is formed by bolting two Face Plates 54 opposite to each other by means of 1½″ Double Angle Strips 53. Each side 50 and 51 of the wheel rim comprises eight Channel Segments bolted together to form a complete circle. The two rings thus formed are then placed side by side and joined together by means of eight 1½″ Strips 53a that are bolted on the inside of the rim.

The rim is secured to the hub by eight 4½″ Strips 52 that are bolted at their outer ends to 1″×½″ Angle Brackets secured to the 1½″ Strips 53a. The inner ends of the Strips 52 are bolted to the Face Plates. Before finally tightening the bolts the wheel should be lined up so that it will run true on the crankshaft, and this is easily done by passing a length of Meccano Rod through the bosses of the Face Plates and adjusting the various bolts and Strips until the wheel revolves quite true on the Rod. While the wheel is still on the Rod tighten all nuts securely.

Assembly of the Engine

Commence assembly of the engine proper by placing the crankshaft together with the connecting rods in its bearings. Referring to the plan view of the model (Fig. 8) it will be seen that end play of the crankshaft is taken up by means of Collars placed on the shaft in the various positions indicated. A Collar is required also on each end of the crankshaft between the Bosses of the Eccentrics 33c and the faces of the outer Architraves 13.

The flywheels may now be passed over the ends of the crankshaft and the set-screws of the Face Plates forming their hubs tightened quite securely. Care should be taken to tighten all four set-screws in each wheel hub so that the flywheel will be firmly secured to the shaft, otherwise the wheel will move round the shaft under its own momentum—a result that is technically known as "creeping." In a real engine, "creeping" is usually due to misfitting "keys," the small pieces of metal partly sunk into the shaft which engage a slot cut in the hub of the flywheel.

The 8″ piston rods 38 (Fig. 4) carry at their inner ends small Fork Pieces 40. Each of the connecting rods 83 (Fig. 6) is pivoted on a 1″ Rod passed through the end holes of the rear pair of 5½″ Strips, and held in position by securing to each of its ends a Strip Coupling 39 (Fig. 4). These Couplings form the crosshead guide shoes and as previously explained the slots of the Strip Couplings are arranged to slide on the flanges of the Angle Girders 27 and Strips 28 (Figs. 3 and 4), thus forming very effective and smooth working guides for the piston rods.

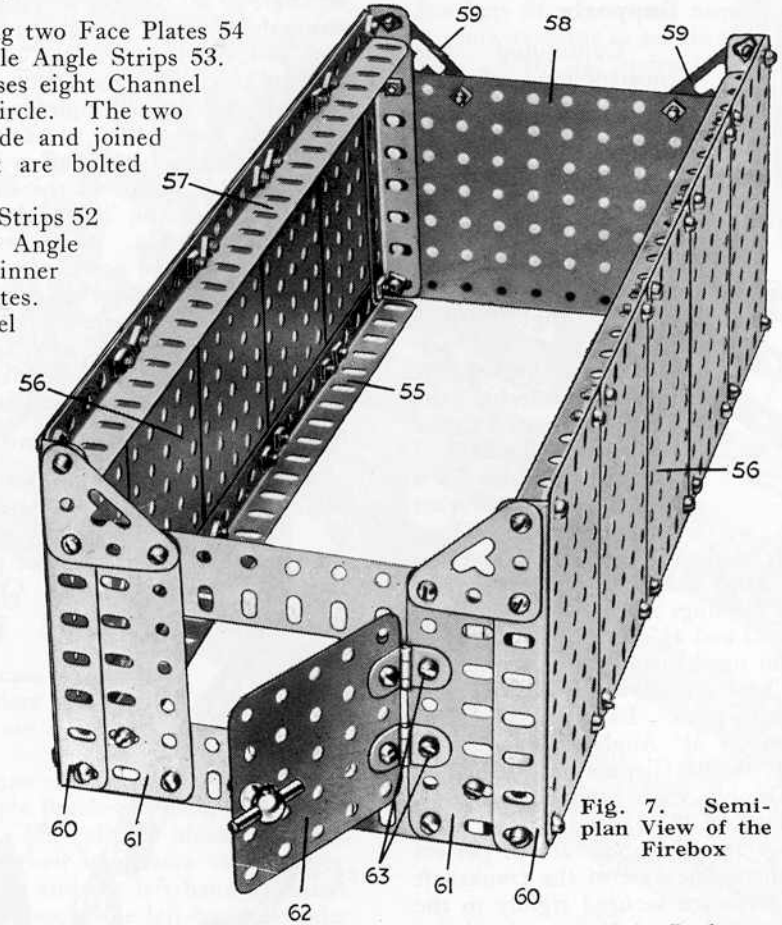

Fig. 7. Semi-plan View of the Firebox

It will be noticed that each of the piston rods extends right through the cylinder and carries at its further end an Eye Piece 37 (Figs 1 and 4) which is arranged to slide freely on one of the Strips 18 (Fig. 3).

The Piston Valves

The valve gear is shown clearly in Figs. 1 and 4. The valves, which are of the piston type, each consist of two 1″ fast Pulleys 36 that are secured to an 11½″ Rod that forms the valve rod.

The valve rods pass through the bosses of the front Bush Wheels of each valve chest, through the Pulleys 36, and out through the bosses of the rear Bush Wheel 25 (see Figs. 3 and 4).

As the exact location of the Pulleys 36 on the valve rod can only be determined by experiment, that is, rotation of the crankshaft when the model is completely assembled, their set-screws should not be tightened at this stage. The valve rods pass through guides formed by the 1″×1″ Angle Brackets 31 (Fig. 4) and each Rod carries a small Fork Piece 34 to which the eccentric rods 33 are connected pivotally by a lock-nutted bolt (S.M. 263.)

The Centrifugal Governor

The 6½″ vertical Rod 45 (Fig. 4) of the governor is journalled at its lower end in a 1½″ Strip bolted to the inner Angle Girder 14 (Fig. 3) and a 2½″ Strip 41 that is bolted across the ends of the Strips 28 (Fig. 3). The Rod is free to rotate in its bearings and is held loosely in position by means of Collars secured to the Rod on each side of Strip 41.

The governor weights comprise four 1″ fast Pulleys that are secured on 1″ Rods passed through the end holes of 1½″ Strips 45a. The Strips 45a are attached pivotally by a bolt and two nuts to Angle Brackets that are bolted to a Bush Wheel 46 secured on the vertical Rod 45. The lower 1½″ Strips are pivoted in a like manner to a further Bush Wheel that slides freely on the Rod 45. The latter also carries a Contrate 44 which is secured firmly in

position and engages a 1″ Gear Wheel 42a that is secured on the end of a 1½″ Rod 42. This Rod 42 is journalled in the centre holes of the Double Angle Strips 30 (Fig. 3) and carries at the opposite end to the Gear 42a a ½″ Pinion 43 that is secured to the Rod in position to engage the Contrate Wheel 32a (Fig. 4) that is on the crankshaft.

As the crankshaft rotates, motion is transmitted to the vertical Rod 45, and as the speed of rotation increases, centrifugal force causes the governor weights to fly outwards, with the result that the lower Bush Wheel moves up the vertical Rod 45. In a practical engine this rising movement is made use of to shut the main steam valve or open it as the case may be, thus admitting or shutting off steam to the cylinders and so keeping the revolutions of the engine fairly constant.

Building the Boiler

Each end of the boiler is formed by a Hub Disc, to the rims of which are bolted twenty-one 12½″ Strips 72 (Fig. 1). The underneath portion of the boiler, i.e., the part that lies inside the boiler mounting, is left uncovered.

The boiler fittings comprise a steam pressure gauge, a water gauge and a "dead weight" safety valve. In actual practice the water gauge consists of a length of stout glass tube mounted at each end in hollow brass sockets. The sockets are directly connected with the boiler water so that the water flows into the glass tube and takes up the same level as that of the water actually in the boiler. The gauges are, of course, fitted about 12 inches below the normal working water level. In the model the gauge consists of a 1½″ Rod (representing the glass tube), that is held in two Handrail Supports, the latter being secured to the front end plate of the boiler. The arrangement is shown clearly in Fig 1.

The pressure gauge is formed by a 1⅛″ Flanged Wheel bolted to the boiler end plate by means of a ⅜″ Bolt. The dead weight saftey valve comprises two 1⅛″ Flanged Wheels 71 held flange to flange on a 1½″ Rod that is passed through a hole in the top Strip of the boiler, as shown, and held in position by a Collar secured to the Rod inside the boiler.

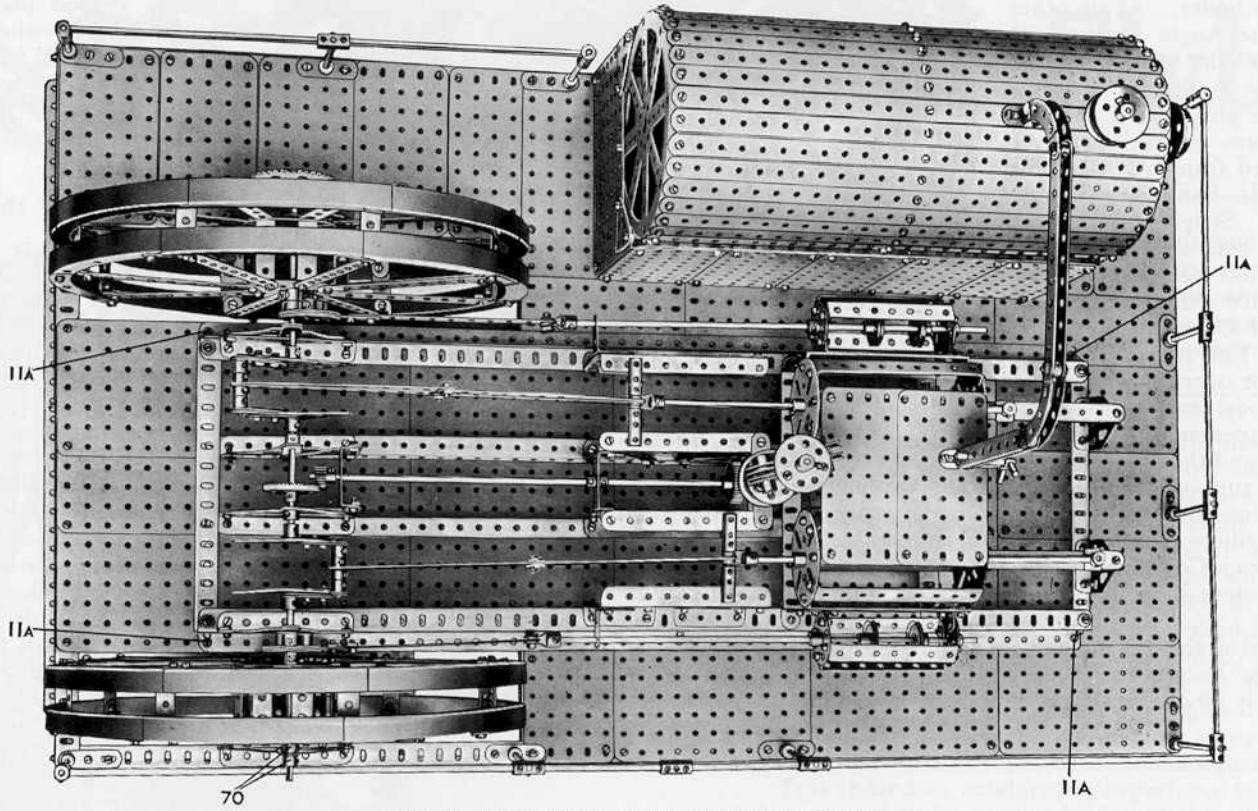

Fig. 8. Plan View of the Complete Model

Details of Boiler Mounting, Fire Box, etc.

The boiler is mounted above the fire box as shown in Fig. 1. The fire box is illustrated in detail in Fig. 7. Each side is formed by five 4½″×2½″ Flat Plates 56 that are bolted at their ends to 12½″ Angle Girders 55 and 57. The rear end is a 5½″×3½″ Flat Plate 58 that is bolted to the Angle Girders 55 and 57 and is further secured by means of two Corner Brackets 59, which also form the saddles on which the boiler rests. At the fire door end, two 4½″ Angle Girders 60 are bolted to the Angle Girders 55 and 57, as are also two horizontal 5½″ Flat Girders. Two 3½″ Flat Girders 61 may now be secured between the latter as shown, after which two further Corner Brackets are bolted in position in a similar manner to the Corner Brackets 59 at the rear end.

The fire door is formed by a 2½″×2½″ Flat Plate that is attached by two Meccano Hinges 63 to one of the Flat Girders 61. A Handrail Support, in which is secured a 1″ Rod, serves as a handle.

The firebox unit is now complete and may be secured to the base by bolting it in the position shown in Figs. 1 and 8. The securing bolts pass through the Angle Girder 55 (Fig. 7) of the fire box and also through the Flat Plates of the base, the whole being placed so as to cover completely the space left to receive it in the base (see Fig. 2).

The boiler may next be bolted in position above the fire box. It is secured by bolting the Hub Discs to the 5½″ Flat Girder at the front end of the fire box, and to the Flat Plate 58 (Fig. 7) at the rear. One bolt in each of the above

positions will be quite enough to ensure that the boiler is held firmly in position. In the prototype the steam is drawn off from the boiler via the main steam pipe 48, which is connected to the steam chest of the engine (see Fig. 4).

The pipe is made up from four 5½″ Strips and four 2½″ Curved Strips connected together. It is secured to the boiler by bolting the ends of the Curved Strips to two Angle Brackets that, in turn, are bolted to the boiler. At its other end it is connected to the Angle Brackets 24 (Fig. 3) bolted to the top of the steam chest.

The main steam pipe is provided with a stop-valve 49 (Fig. 4) the purpose of which is to shut off or admit steam to the engine as required. It is constructed from a 2″ Rod that is journalled in a Double Bent Strip before passing through the 5½″ Strips forming the steam pipe. The Rod is held in position by a Collar, secured on the Rod between the two 5½″ Strips. Four Threaded Pins screwed into the spider of a Universal Coupling or Swivel Bearing secured on the 2″ Rod form a very neat and realistic handwheel for operating the valve.

To complete the model and at the same time add realism to its appearance it now only remains to fix handrails round the base as shown in Fig. 1. The handrail supports are formed by eleven short Rods secured in Cranks. It will be noticed that the corner supports are secured in ordinary Cranks while the intermediate supports are held in Double Arm Cranks. Each supporting rod carries a Coupling that is secured transversely, as shown. These Couplings form sockets in which to secure the 8½″ and 6½″ Axle Rods comprising the handrails.

Having now assembled all the moving parts of the engine, final adjustments may be made. Each of the Eccentrics 33c are to be secured to the crankshaft at an angle of approximately 90 degrees with its respective crank pin. Careful attention should be paid to the alignment of the piston rods, crossheads, and crankshaft and it may be necessary to make certain minor adjustments to these parts in order to ensure that everything works quite freely. Apply a little oil to all gears, crank pins, crosshead slides, piston rods, and crankshaft bearings, etc.

It is a good plan to turn the engine by means of the Flywheel for a few revolutions, when, if it is at all hard to turn or unsteady in its movement, the trouble is generally to be found in one of the rods being out of line with its journals. Careful inspection will soon locate the fault.

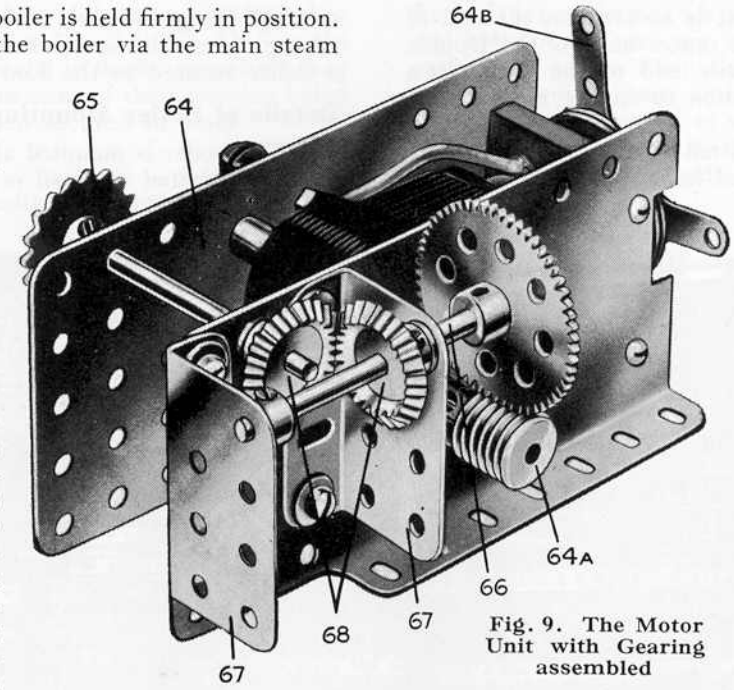

Fig. 9. The Motor Unit with Gearing assembled

Arrangement of the Driving Motor

The model is operated by a 6-volt Meccano Electric Motor. It should be bolted to the base in the position shown at 64 in Fig. 1. Fig. 9 is a detailed view of the complete Motor unit and the gears through which the drive is transmitted to the engine crankshaft.

The Motor armature spindle carries a Worm 64a engaging a 57-teeth Gear Wheel secured to the Rod 66 that is journalled in Girder Brackets 67 bolted to the side plates of the Motor. Besides the 57-teeth Gear the Rod 66 carries also a ⅞″ Bevel 68 that engages a second Bevel secured on a Rod journalled in the Motor frame plates. This latter Rod carries also a 1″ Sprocket Wheel 65. Both the Rod 66 and the Rod of the Sprocket 65 are held in position by Collars. Washers should be placed on the Rods behind the bosses of the Bevels 68, for spacing purposes. The drive from the Motor is conveyed by Sprocket Chain from the Sprocket 65 to a 2″ Sprocket secured on the crankshaft, as shown in the plan view of the model (Fig. 8).

List of Parts Required to Build the Meccano Twin Cylinder Steam Engine

25	of No.	1	6	of No.	9a	2	of No.	14	1	of No.	27a	10	of No.	48c	4	of No.	76	4	of No. 103b
2	,,	1b	14	,,	9b	2	,,	15a	2	,,	28	2	,,	50a	1	,,	81	22	,, 108
12	,,	2	1	,,	9c	12	,,	16a	2	,,	30	17	,,	52a	4	,,	90a	8	,, 109
38	,,	2a	1	,,	9d	1	,,	16b	1	,,	31	22	,,	53a	6	,,	94	6	,, 111a
7	,,	5	8	,,	9e	5	,,	18a	1	,,	32	18	,,	59	1	,,	95a	2	,, 111c
10	,,	6	2	,,	9f	5	,,	18b	633	,,	37	13	,,	62	1	,,	96	2	,, 114
30	,,	6a	22	,,	12	3	,,	20	13	,,	37a	5	,,	62b	8	,,	99	4	,, 115
4	,,	7	2	,,	12a	2	,,	20a	28	,,	38	10	,,	63	8	,,	99a	2	,, 116a
15	,,	7a	38	,,	12b	8	,,	22	1	,,	45	4	,,	63b	4	,,	99b	2	,, 118
15	,,	8	7	,,	13	6	,,	24	19	,,	48	9	,,	70	2	,,	103	32	,, 119
4	,,	8b	5	,,	13a	1	,,	26	8	,,	48b	1	,,	72					

2	of No.	126a
2	,,	130
4	,,	133
5	,,	136
1	,,	143
2	,,	161
1	,,	165
2	,,	166
1	6-volt Electric Motor	