Meccano Giant Dragline

A wonderful Electrically-operated Model of a 300-ton Excavating Machine, incorporating five distinct movements.

Special Features

The model is driven by a 4-volt Electric Motor and comprises the following five movements, all of which may be thrown in or out of gear on operation of a lever or hand wheel: Digging, hoisting and lowering, luffing, slewing, and travelling. The Gear Box is of a particularly simple and ingenious design.

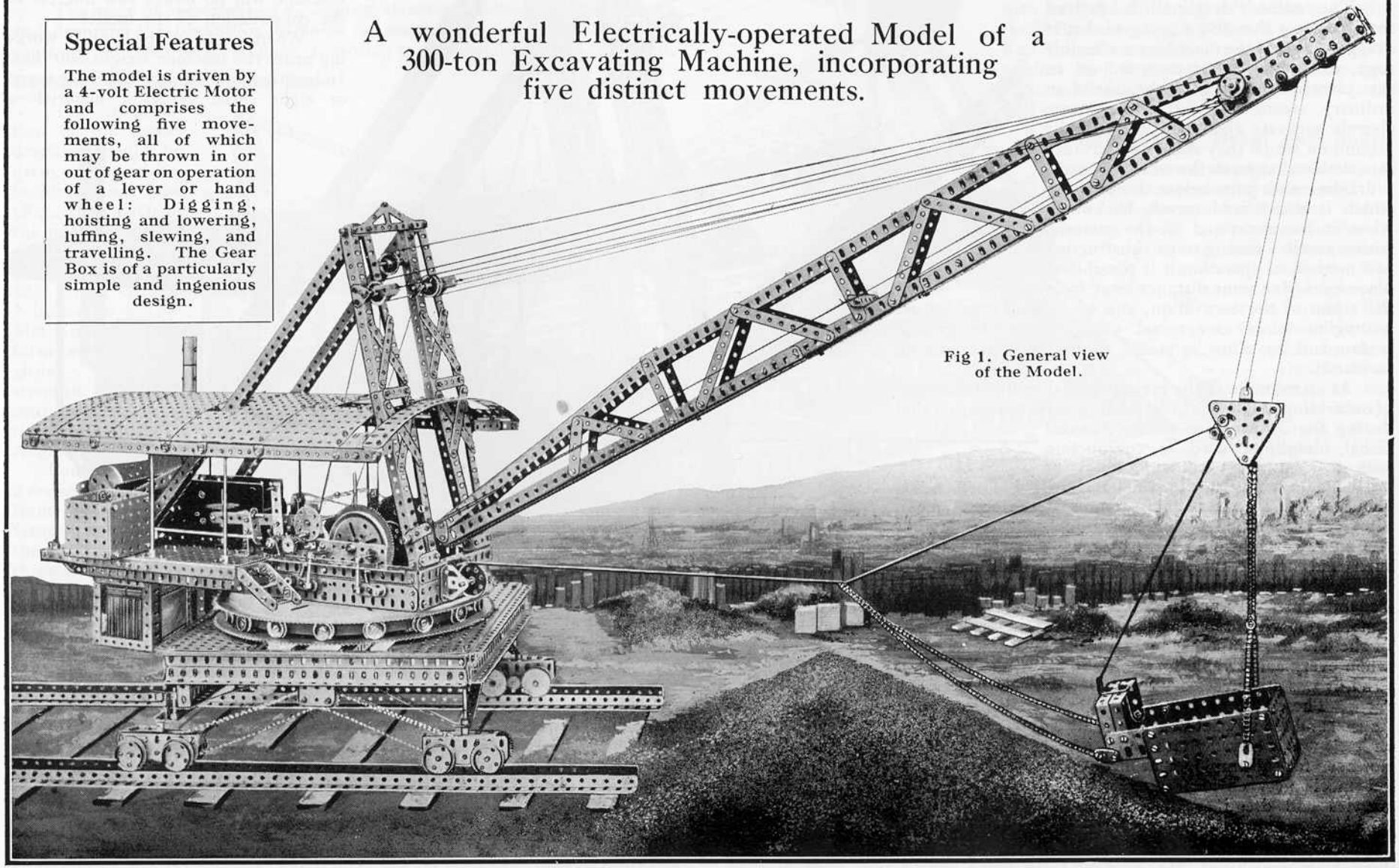

Fig 1. General view of the Model.

1228/5 *Published by* MECCANO LTD., OLD SWAN, LIVERPOOL Printed in England

THE dragline is a wonderful machine employed largely on excavation work, such as the making of canals and railway cuttings, etc. In construction it is somewhat similar to the steam shovel (or mechanical navvy, as it is sometimes termed), but differs considerably in its method of operation.

The name "dragline" is derived from the fact that the digging bucket is dragged towards the machine on a flexible rope, instead of being mounted on an arm pivoted to a jib, as in the case of an ordinary steam shovel. While steam shovels excavate above the level of the ground on which they stand and advance into the excavation as the work proceeds, a dragline excavates below the level on which it stands and travels backwards when it has excavated all the material within reach. Owing to its construction and method of operation it is possible to place a dragline some distance away from the scene of the excavation, and because of this feature a dragline is of exceptional value where the ground is too soft to allow a steam shovel with its short jib to stand.

As an example of the great practical value of this type of excavating machine, it will be of interest to mention that during the construction of the Panama Canal, draglines, used in conjunction with steam shovels, did the work of thousands of labourers at a fraction of the cost. Apart altogether from the fact that their upkeep was nothing like the amount that would have been required for wages if men had been employed, they helped considerably in solving the difficult problem of housing and feeding. The Panama Canal was cut through a practically uninhabited zone, and it was therefore necessary to erect large numbers of shelters and temporary houses for the workmen. Even when every conceivable form of labour-saving device was used, it was still necessary to employ over sixty thousand men. These men, with their wives and families, had to be housed and fed in what was practically a desert area. This in itself was a very big task, but if it had not been for the employment of wonderful mechanical devices such as steam navvies and draglines, the number of labourers required would have been so enormous that it would have been practically impossible to find accommodation for them, which only goes to show how great a part mechanical devices really played in the construction of this famous canal.

The Prototype of the Meccano Model

The Meccano model has been designed to resemble as closely as possible the largest dragline in the world. Its huge prototype was built by Ruston and Hornsby, Ltd. (Lincoln), for service in connection with irrigation schemes in India, and the following details of this machine will no doubt add interest to the construction of the model.

When fully equipped and in working order the machine weighs 300 tons. In less than one minute it will dig seven or eight cubic yards of material—a

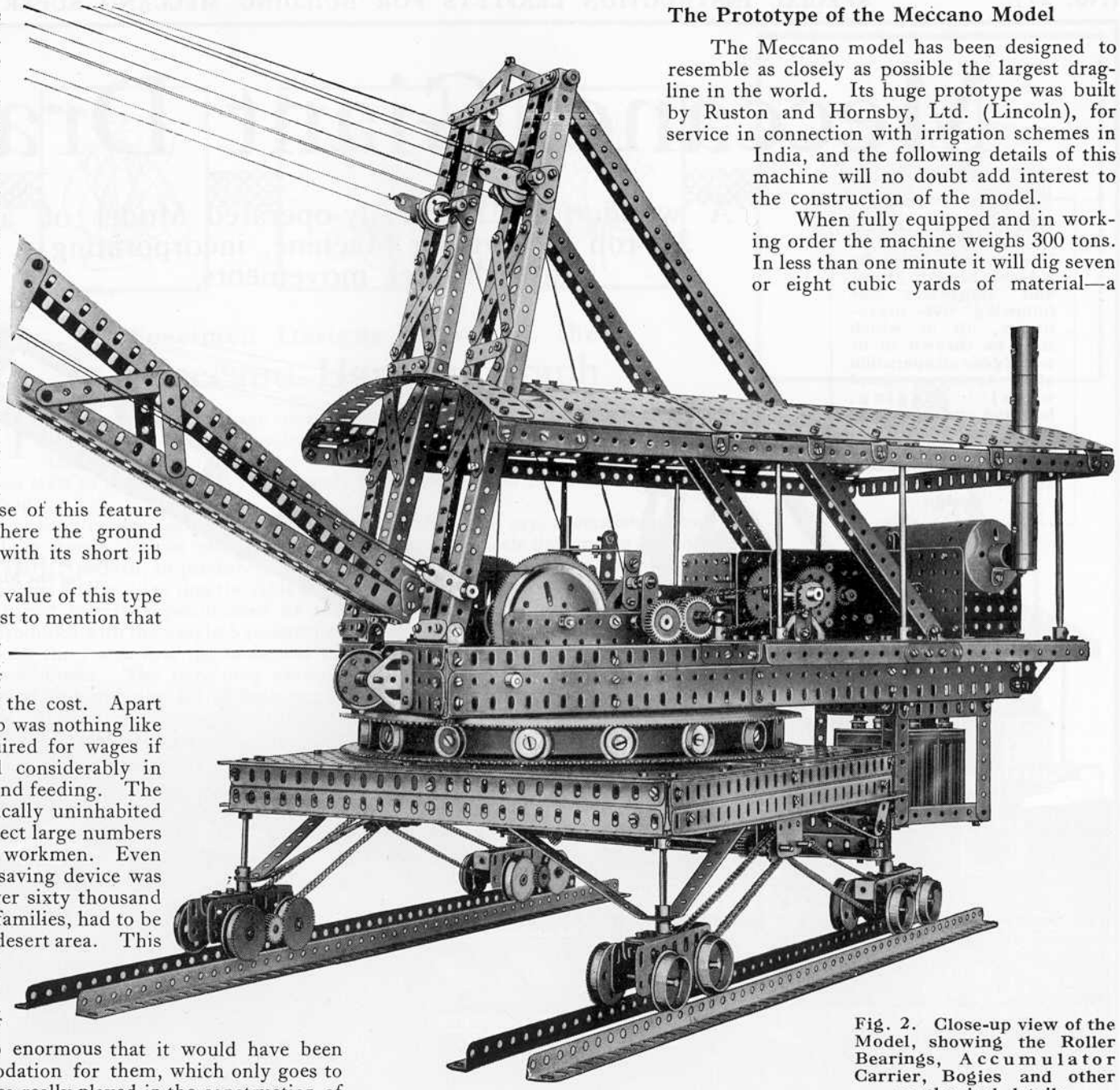

Fig. 2. Close-up view of the Model, showing the Roller Bearings, Accumulator Carrier, Bogies and other mechanical details.

single bucket load—and deposit it 200 feet away from the point whence it was excavated. This means that it would nearly fill an 8-ton coal wagon in one cut! The jib is 120 feet in length and the drag-rope from the bucket $1\frac{3}{4}$" in diameter. The main engines develop 400 h.p. and, in addition to these, separate engines of 200 h.p. are fitted for slewing the jib and superstructure. The machine may also be used as a crane, in which capacity it will lift a load of 22 tons at a radius of 125 feet.

The cycle of operations—i.e., digging, slewing, discharging, slewing back, and dropping the bucket in readiness for another cut—is completed in the short period of 45 to 55 seconds, according to the material being excavated.

Building the Model: The Base

The construction of the model dragline should be commenced by building the base (Fig. 3). Each of the sides are exactly similar; they are composed of four $12\frac{1}{2}$" Angle Girders 1 bolted to a $12\frac{1}{2}$" Flat Girder so as to form an H-section girder of great strength, and they are connected together at the corners by 1"×1" Angle Brackets.

Four $12\frac{1}{2}$" Angle Girders 2 are secured to the top of the frame thus formed and a Geared Roller Race 3 is bolted thereto by means of $\frac{3}{8}$" Bolts, three Washers being placed on the shanks of the bolts between the Angle Girders and the Race, for spacing purposes. A $5\frac{1}{2}$"×$3\frac{1}{2}$" Flat Plate is attached at each corner in order to fill in the spaces left by the Race at the corners of the base.

The bogies at the front end of the machine (which is the far end in the illustration under consideration) are mounted on $3\frac{1}{2}$" Rods 4 passed through the holes in the Angle Girders 1 at each corner and retained in position by Collars; the Rods are supported further by means of $5\frac{1}{2}$" Strips bent as shown and bolted to the $12\frac{1}{2}$" Girders.

Secured halfway along the Angle Girders 1 are two Channel Bearings placed one on either side; in each of these Channel Bearings is journalled two $1\frac{1}{2}$" Rods carrying two $\frac{3}{4}$" Sprockets 5 and two $\frac{1}{2}$" Pinions 6. An $11\frac{1}{2}$" Rod 7, also journalled in the Channel Bearings, is further supported near its centre by 2" Strips that are bolted to Trunnions secured to a $2\frac{1}{2}$"×$2\frac{1}{2}$" Flat Plate that is bolted across the centre pair of Girders 2 by $\frac{3}{8}$" Bolts. The Trunnions are packed up with Washers so that the end holes of the 2" Strips shall be in alignment with those in the Channel Bearings and allow the Rod 7 to turn freely. The latter Rod carries at either end a $\frac{1}{2}$" Pinion that meshes with both the Pinions 6 on the Rods carrying the $\frac{3}{4}$" Sprockets 5. A $\frac{7}{8}$" Bevel, secured to the Rod 7, meshes with a second Bevel on the vertical Rod 8 that passes up into the gear box and forms the pivot about which the superstructure turns.

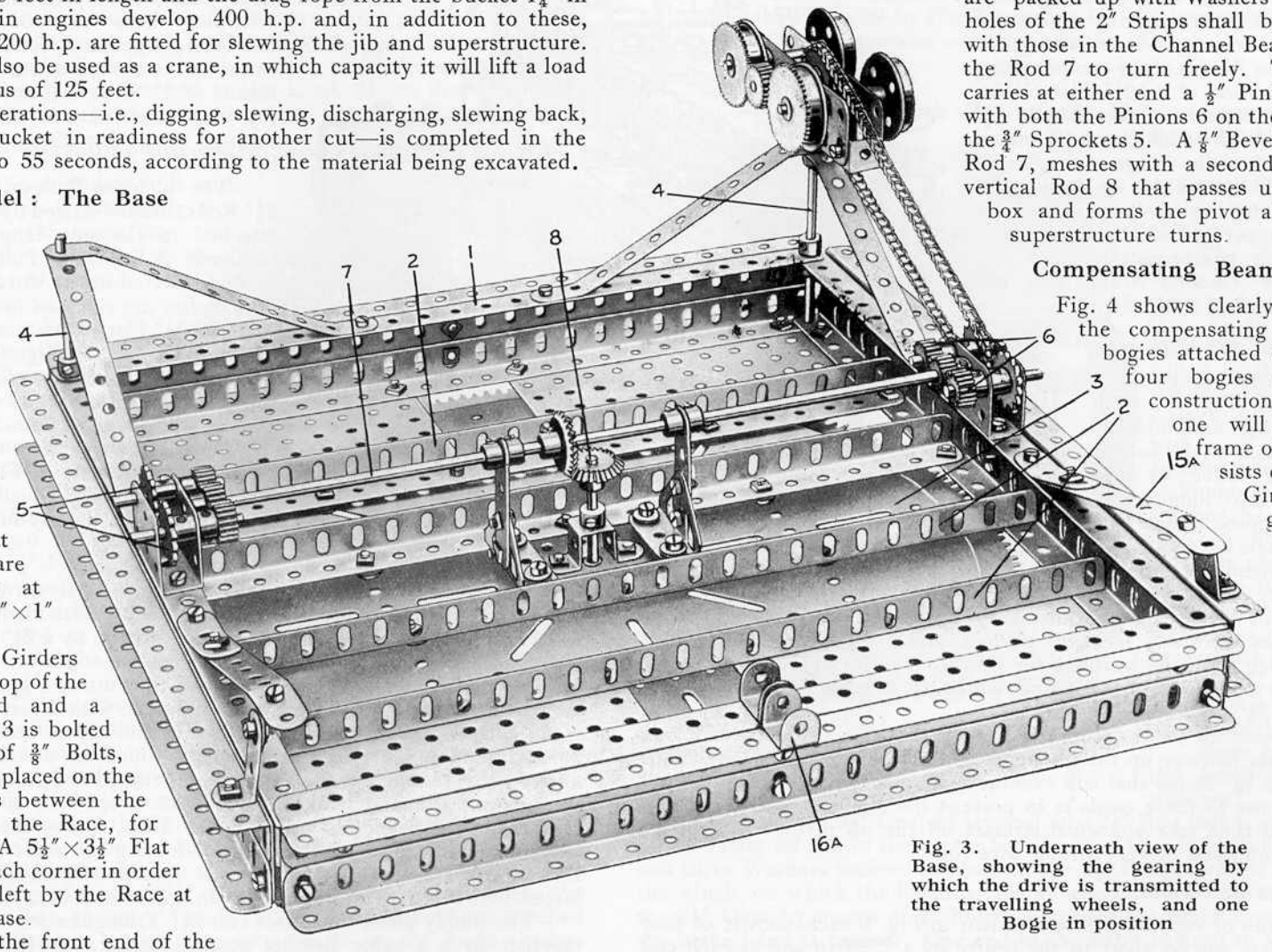

Fig. 3. Underneath view of the Base, showing the gearing by which the drive is transmitted to the travelling wheels, and one Bogie in position

Compensating Beam and Bogies

Fig. 4 shows clearly the details of the compensating beam and the bogies attached thereto. As all four bogies are similar in construction a description of one will suffice. The frame of the bogie consists of two $3\frac{1}{2}$" Flat Girders held together by three Double Brackets, to two of which the Crank 9 is bolted. The drive for each bogie is taken off the $\frac{3}{4}$" Sprocket 5 (Fig. 3) by means of Sprocket Chain to the 1" Sprocket 10 mounted on a short Rod that is journalled in the bogie side frames and which carries a $\frac{3}{4}$" Pinion. The latter meshes with the 50-teeth Gear Wheels 11 secured on the wheel axles. By this means it will be seen that the drive is transmitted to all the sixteen wheels, a fact which ensures the maximum adhesion and reduces wheel slip to a minimum.

The compensating beam consists of two $12\frac{1}{2}$" Angle Girders 12 between the flanges of which is bolted a $12\frac{1}{2}$" Flat Girder. To the lower edge of the Flat Girder four $5\frac{1}{2}$" Angle Girders are bolted flanges outward, the space between their centre ends being filled in by a $1\frac{1}{2}$" Angle Girder on each

side of the Flat Girder. As will be seen the Angle Girders are arranged on the slant, in order to give the maximum depth in the centre of the beam and a taper towards each end, this shape in practice giving a girder of great strength and rigidity. Extra strength is given to the lower flanges of the compensating beam by the addition of a 12½″ Flat Girder bolted along the bottoms of the 5½″ and 1½″ Angle Girders. A Threaded Crank 13, bolted to the underneath of the flange of the Girder 12 at each end, carries in its bore a 1″ Threaded Rod having a Bush Wheel 14 secured to its upper end. The functions of these and of the compensating beam are described in the "General Notes" that will be found at the end of the leaflet.

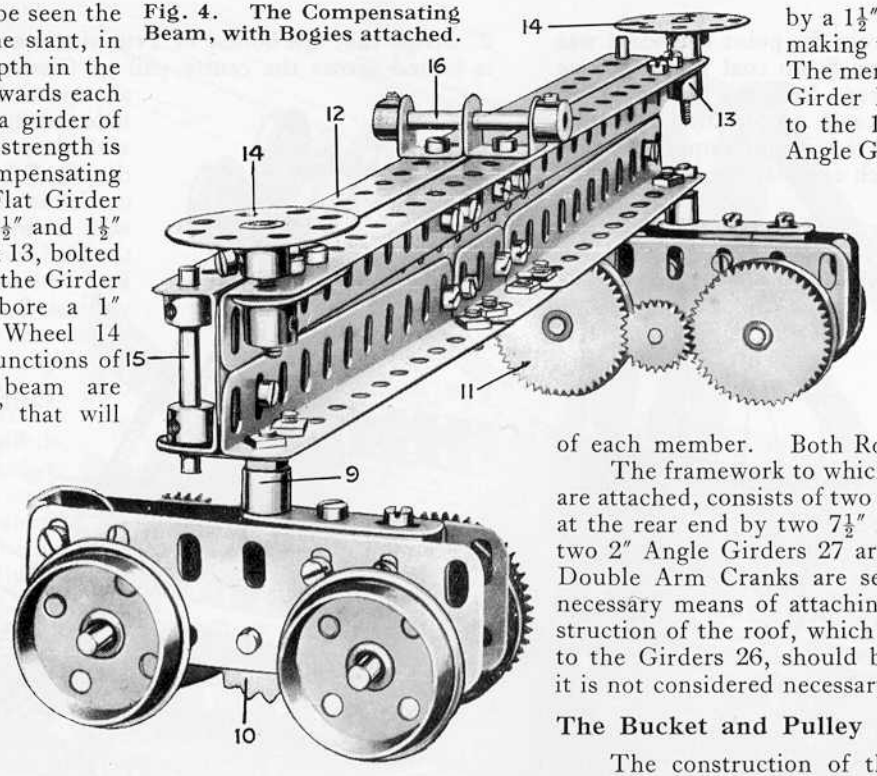

Fig. 4. The Compensating Beam, with Bogies attached.

Construction of the Jib

Each bottom longitudinal member of the jib (Fig. 5) is built up from two 18½″ and one 9½″ Angle Girder, each of the former overlapping the latter by four holes. Each top longitudinal member is composed of one 18½″ and two 12½″ Angle Girders. The top and bottom members of the jib are connected by 3″ Strips at the centre portion of their length, whilst they taper down at each end to 1″ Triangular Plates 17, which form the jib foot, and to 5½″ Flat Girders 18 at the top end which form the bearings for the head pulley spindles. The 1″ loose Pulleys 19 are carried on a 3½″ Rod, whilst the 1″ loose Pulleys 20 and 21 are mounted on 2½″ Rods.

As will be seen the jib is adequately braced by Strips. The cords 22 are attached to points halfway up the jib and near the jib head, their lower ends being secured to 1½″ Strips that will eventually be placed on the jib pivot pin 17a. The purpose of these cords is to prevent the swaying of the jib from side to side and thus take abnormal stresses off the jib pivot. In practice the cords are composed of very strong wire rope.

The A-Frames and Roof

The A-frames or vertical members shown in Fig. 9 each consist of four 7½″ Angle Girders spaced apart in the centre by a 2″ Strip and at each end by a 1½″ Strip diagonal bracing in the shape of 3½″ Strips making the whole rigid and giving it a finished appearance. The members are connected together at the top end by two Girder Frames placed on top of one another and bolted to the 1½″ Strips. Two "ties" 23, consisting of 18½″ Angle Girders bolted together to form channel girders, are connected to the top of each vertical member by means of 2″ Rods that are passed through the top end holes of the vertical members and through the girders 23, and retained in position by Collars.

The 1″ loose Pulleys 24 are mounted on 2½″ Rods that are carried by 1″ Triangular Plates attached to the side flanges of the 7½″ Angle Girders. A further 1″ Pulley 25 is carried by a 3″ Rod inserted in the third hole from the top of each member. Both Rod and Pulley are retained in position by Collars.

The framework to which the 5½″×3½″ Flat Plates forming the roof proper are attached, consists of two 18½″ Angle Girders 26 (Fig. 8) connected together at the rear end by two 7½″ Angle Girders, which are overlapped nine holes; two 2″ Angle Girders 27 are attached to the front ends of these Girders 26. Double Arm Cranks are secured in the positions indicated to provide the necessary means of attaching the Rods 28 that support the roof. The construction of the roof, which is secured to a number of Flat Brackets attached to the Girders 26, should be quite clear from the illustration and therefore it is not considered necessary to give a detailed description.

The Bucket and Pulley Block

The construction of the bucket (Fig. 10) is extremely simple. The sides and the bottom are composed of 4½″×2½″ Flat Plates joined together by 4½″ Angle Girders, while the back end is filled in by a 2½″×2½″ Flat Plate that is attached to 2½″ Angle Girders bolted to the edges of the 4½″ Plates. The front edge of the bottom Plate (which is the cutting edge in practice and digs into the material to be excavated), is provided with "tines" or teeth consisting of 2″ Strips. The Sprocket Chain "bridle" 29 is connected to the front portion of the bucket by Flat Brackets, which are attached thereto by lock-nutted bolts, the same method applying to the other Sprocket Chain connecting the pulley block and bucket. It will be noted that a cross-piece or yoke, consisting of a 2½″×½″ Double Angle Strip, spaces the two lengths of the latter chain apart, and prevents them fouling the sides of the bucket. The Double Angle Strip is attached to the Sprocket Chain by ⅜″ Bolts, which are forced between the links of the Chain and retained in place by nuts.

The pulley block comprises two 2½″ Triangular Plates that are connected together by a Double Bracket at each corner. A 1½″ Pulley forming the

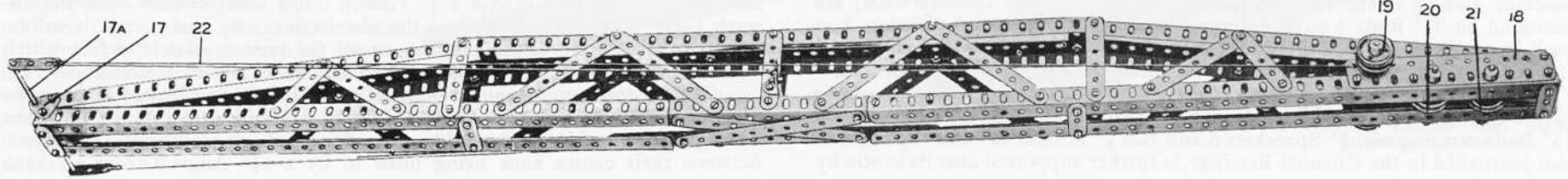

Fig. 5. Construction of the Jib, showing the jib head pulleys, pivot pin, etc.

"sheave" is carried on the Rod 30, and is spaced from the sides of the block by Washers. Two 1" Triangular Plates carry a short Rod on which is mounted a ½" loose Pulley. The bolts securing the 1" Triangular Plates to the block, have a Washer placed under each of their heads in order to prevent the shanks of the bolts fouling the sheave. A length of cord is secured to the front portion of the bucket as indicated in the illustration, and led over the ½" loose Pulley; it will eventually be attached to the Hook 31 on the end of the digging rope. This cord regulates the tilt of the bucket.

Construction of the Swivelling Superstructure

Fig. 7 shows the complete unit with Gears, Motor, etc., in place, whilst Fig. 6 gives a very good idea of the construction of the framework with all gears removed. We will consider first the latter illustration.

Each side member of the frame consists of two parallel 18½" Angle Girders 32 and 33 (Figs. 6 and 7) and two 9½" Flat Girders bolted end to end. The arrangement of these parts will be clear on reference to Fig. 2. The front end of the members are joined together by two 5½" Angle Girders and a 5½" Flat Girder arranged in a similar manner to those of the side members and connected to the latter by means of 1½" Angle Girders. Two 1½"×½" Double Angle Strips 34 are bolted to the top 5½" Angle Girder and two Trunnions 35 are secured to the 5½" Flat Girder as shown in the illustrations. A Washer is placed on the shank of each retaining bolt between the flange of the Trunnion and the Flat Girder, in order that the rim of the Pulley 35a shall clear the latter.

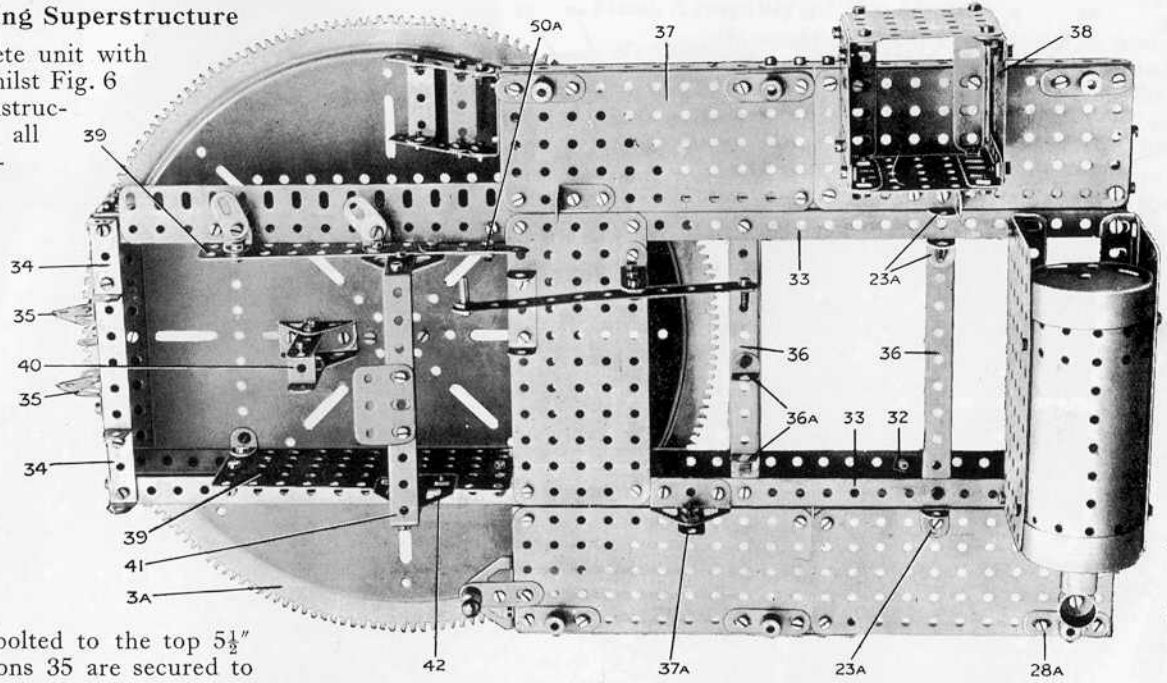

Fig. 6. Plan view of the swivelling Superstructure, with Roof and all gears removed.

Two 5½" Angle Girders bolted to the rear end of the frame carry the 5½"×2½" Flat Plates between which the boiler is mounted. The Motor "bearers" 36, consisting of further 5½" Angle Girders, are bolted across the Girders 33 in the positions shown. The 5½"×2½" Flat Plates 37 are attached to 5½" Angle Girders that are bolted—flanges outward—to the Angle Girders 33, 5½" and 2½" Angle Girders being attached to their outer edges to strengthen them. Double Arm Cranks 28a are bolted to the Plates 37; they will receive the ends of the Rods 28 supporting the roof. The coal bunker 38 is built up from 2½"×2½" Flat Plates and 2½" Angle Girders, and secured in position on the Plates 37 by nuts and bolts.

The sides of the gear box proper consist of two 5½"×2½" Flat Plates 39 that are secured to the Angle Girders 33 by 5½" Angle Girders bolted to the underside of the former Girders. As will be seen from the illustration, the entire structure is mounted on the upper, or movable, Geared Roller Race 3a, to which are bolted in the position shown, two Trunnions that carry the 2½" Strips 40. The 4½" Double Angle Strip 41 is bolted between 1½" Strips secured to the Plates 39 by Flat Trunnions 42. This completes the swivelling structure and it only remains now to insert the gearing.

Details of the Gear Box

Fig. 7 is a plan view with all the Gears, Motor, brakes, etc., in position. Provided that the directions are followed intelligently and carefully, little difficulty should be experienced with this portion of the model.

The Motor is bolted down to its bearers 36, its front end being attached to the Angle Brackets 36a (Fig. 6). A 2" Rod, journalled in the side plate of the Motor, carries a 57-teeth Gear Wheel in mesh with a ½" Pinion on the armature spindle, and also a ½" Pinion that engages with another 57-teeth Gear on the 4½" Rod 43a. This Rod also carries a Sprocket 43 and a Worm 64, and is journalled in the Motor side plates and in an additional bearing 37a (Fig. 6) consisting of a 1½" Strip bolted to a Trunnion that is secured to the Angle Girder 33.

Now let us consider the hoisting and digging winches. The hoisting winch consists of a 3½" Gear 44 secured on a 2½" Rod that is journalled in one of the Plates 39 and in the centre bearing 40. One Bush Wheel, one Collar, and three Washers secured in place on the 2½" Rod, represent the "barrel" of the winch, on which the hoisting rope is wound. A 3" Pulley 45 secured to the 3½" Gear by means of ⅜" Bolts, comprises the brake drum round which the brake band is passed. One end of the latter is fixed to a portion of the framework and the other end is attached to a Coupling that is secured at right angles to a short Rod journalled in both the side plate 39 of the gear box and in the 9½" Flat Girder comprising the side member. The outer end of the Rod carries a Crank (see Fig. 1) in the end holes of which a 1½" Rod 46 is mounted pivotally by means of a Collar. A set-screw is passed through the end hole of the Crank and screwed home in the tapped hole of the Collar. The brake is kept in the "off" position by means of a short length of Spring Cord fastened by nuts and bolts to the Crank and to the 7½" Flat Girder above it; the Crank

is spaced away from the side by two Washers on the Rod. When it is desired to hold the brake on for any length of time, the Rod 46 or "brake pedal" is pushed down, thus applying the brake, and the pivoted Flat Bracket is swung over the end of the brake pedal to hold it down.

The details of the digging winch are exactly similar to that just described, with the exception that the brake-actuating cranks are secured on a $6\frac{1}{2}$" Rod 47 that passes completely across the gear box and is journalled in the side frames. A 5" Rod 48, journalled in the third hole from the top and the fourth from the back edge of the Flat Plates 39, carries a Worm and a 50-teeth Gear 48a in the positions shown.

The luffing winch consists of a 5" Rod 49 to which is secured a 50-teeth Gear Wheel 49a, and a Ratchet Wheel. The Pawl 50, which engages with the teeth of the Ratchet, is mounted on a Pivot Bolt attached to the Strip 50a (Fig. 6). The Pawl carries a Threaded Pin in its tapped hole, by which disengagement with the Ratchet Wheel may be effected when luffing out the jib.

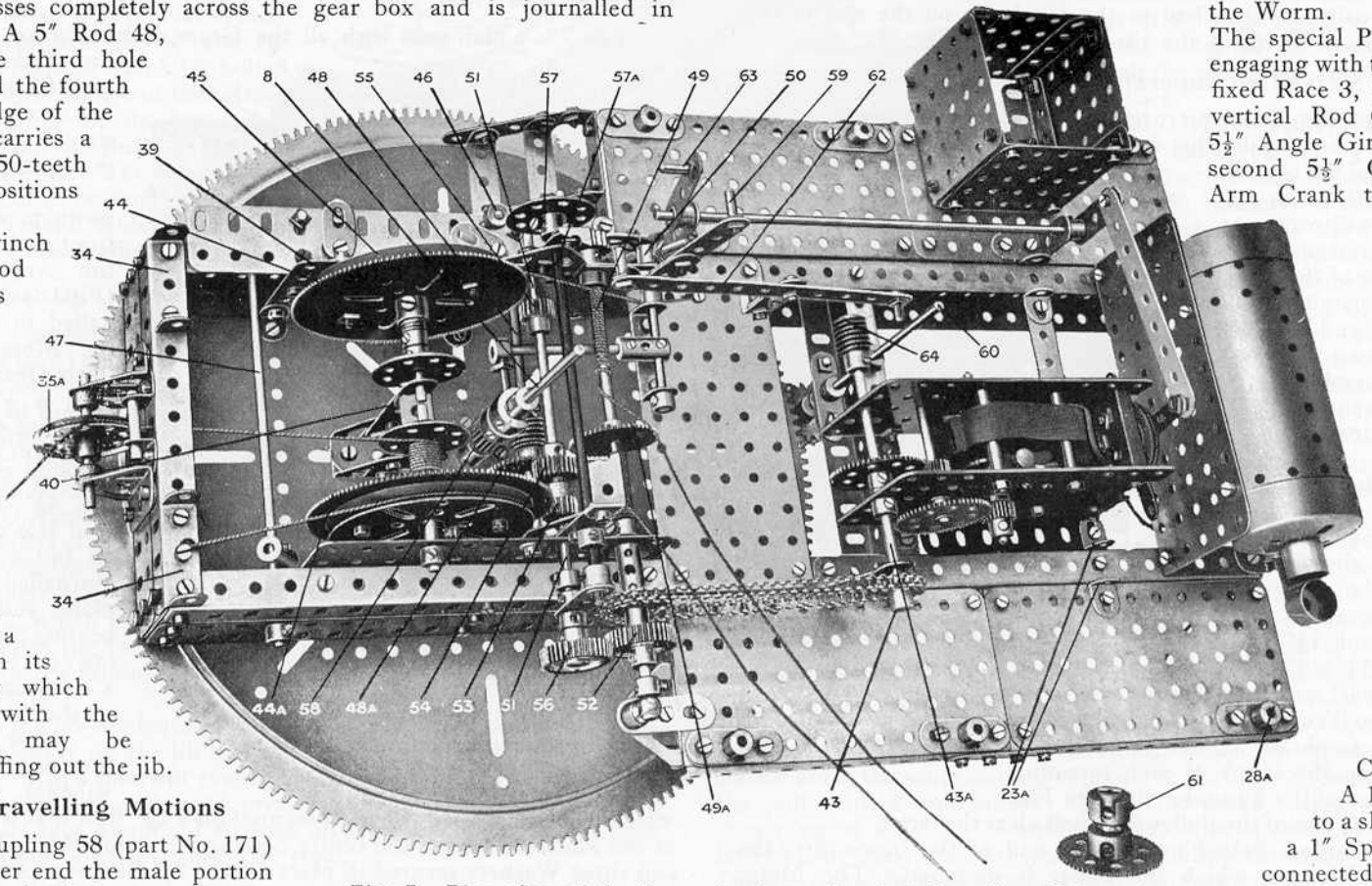

Fig. 7. Plan view of the Superstructure, showing Gear Box, Motor, etc.

Slewing and Travelling Motions

A Socket Coupling 58 (part No. 171) carries at its upper end the male portion of a Dog Clutch and at its lower extremity a $\frac{1}{2}$" Double Width Pinion that is in constant engagement with the Worm on the Rod 48. The Socket Coupling is placed on the Rod 8 and should be perfectly free to revolve on it and only turn the Rod when pushed up into engagement with the female portion of the Dog Clutch that is secured rigidly to the Rod. It should be clearly understood that the Rod 8 is shown in position in the gear box in order to make the working of the latter quite clear; actually the Rod forms part of the travelling base (Fig. 3) and is not in place in the gear box until the entire superstructure is mounted on the lower Roller Race.

The lever 59 controls the travelling movement, and consists of a 3" Strip that is attached by means of a Crank to a short Rod journalled in a $1\frac{1}{2}$" Double Angle Strip, which is bolted to the floor plates. Attached to the Rod by means of a Coupling is a $2\frac{1}{2}$" Rod carrying at its extremity a Threaded Pin which is secured to the Rod by a Collar; the tip of the Threaded Pin engages with the groove turned in the Sleeve Coupling. The vertical movement for engagement or disengagement with the Dog Clutch must not be excessive, otherwise the Double Width Pinion will come out of mesh with the Worm.

The special Pinion (Part No. 167c) engaging with the teeth of the lower fixed Race 3, is secured to a $4\frac{1}{2}$" vertical Rod 60 journalled in the $5\frac{1}{2}$" Angle Girder 36 and also in a second $5\frac{1}{2}$" Girder and Double Arm Crank that is bolted to the lower $18\frac{1}{2}$" Angle Girders 32 (Fig. 6). One portion of a Dog Clutch and a 57-teeth Gear Wheel are connected together by means of a Socket Coupling 61, the complete unit being shown in Fig. 7 removed from its Rod for the sake of clearness. Actually, of course, it is placed on the Rod 60 and operated by the lever 62, the $\frac{3}{8}$" Bolt in the end of which engages with the groove of the Socket Coupling.

A 1" Gear 56 is secured to a short Rod carrying also a 1" Sprocket Wheel that is connected by Sprocket Chain to the $\frac{3}{4}$" Sprocket 43 on the shaft 43a driven by the Motor. A Coupling is secured to the inner end of the short Rod in such a manner that the other end of the Coupling may be fitted on to the projecting end of the Rod 49 and be free to turn thereon. This arrangement forms a convenient support for the inner end of the short Rod, and its outer end is journalled in a bearing consisting of a Handrail Support, which is secured in the boss of a Threaded Crank that is bolted to a Trunnion and to a $5\frac{1}{2}" \times 2\frac{1}{2}"$ Plate that forms part of the flooring. This bearing may be seen in Figs. 2 and 6. Both bearings are worthy of note as they provide a neat and efficient support for a Rod in a difficult situation.

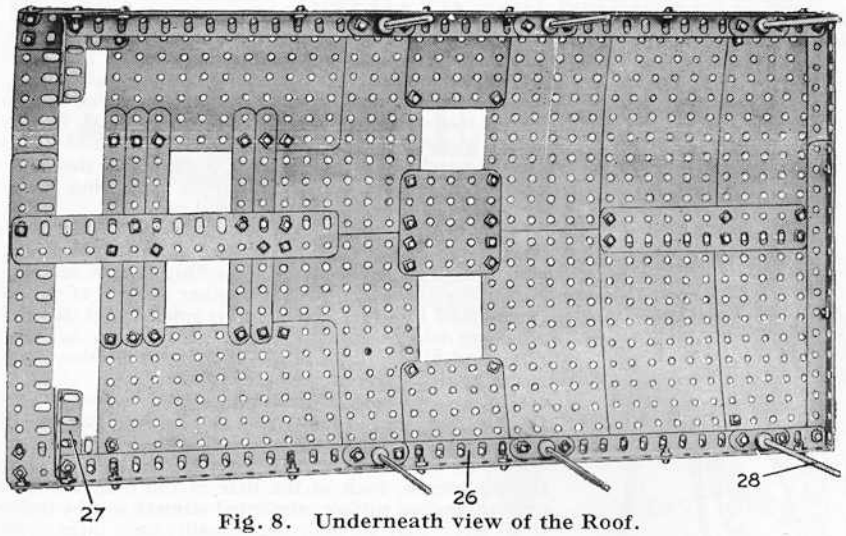

Fig. 8. Underneath view of the Roof.

The correct location of the various Pinions on the 6½″ Rod 51 is of the utmost importance to ensure the proper working of the model. Hence the following instructions should be followed most carefully.

Adjusting the Gear Box

The Rod should first be placed at the extremity of its travel to the left (looking toward the front of the model) and the 1″ Gears 52 and 56 so arranged as to be just in mesh with each other. (A Collar on the other end of the Rod will be secured in place when all the other movements have been adjusted to prevent any further movement of the Rod to the left). In this position of the Rod the ½″ Pinion 53 is in mesh with the 3½″ Gear Wheel 44a of the digging winch, as will be seen from Fig. 7.

A slight movement of the Rod to the right (caused by turning the gear selector wheel 57) should result in the Pinion 55 being brought into engagement with the gear 44 of the hoisting winch, and the Pinion 53 out of engagement with the Gear 44a. By continuing the movement of the Rod to the right, the Gear 44 will eventually become disengaged, at which point the 50-teeth Gear 48a on the Rod 48 should be in mesh with the ¾″ Pinion 54. (The Worm on the latter Rod meshes with the ½″ Double Width Pinion held in the Socket Coupling 58 on the Rod 8, as explained previously). At the extreme limit of the travel of the Rod to the right the ¾″ Pinion 54 comes into mesh with the Gear Wheel 49a on the luffing winch barrel 49, round which the luffing ropes are wound.

It will most probably be found that the Gears 48a, 49a both remain in mesh with the ¾″ Pinion 54 in this extreme position of the Rod 51. This does not matter, however, so long as the Gear 48a comes into engagement with the ¾″ Pinion before the Gear 49a. It is necessary of course that the gears 52 and 56 are in mesh throughout the complete travel of the Rod 51.

The sideways movement of the Rod 51 when changing gear is effected in the following manner: A Threaded Crank runs on the end of the 5″ Threaded Rod 57a, which is journalled in the Trunnions 42 and restrained from sideways motion. The Rod 51 passes through the end hole of the Crank, which is retained in position on the Rod by Collars on both sides as shown. When the hand-wheel 57 secured to the Threaded Rod is rotated, the Threaded Crank advances or recedes along the Rod and so moves the Rod 51. The great advantage of this method of gear selection is that it is impossible for the gears to become disengaged through vibration, etc., as is the case with some other forms of gear changing devices.

The Motor switch is operated from the central controlling position of the model by means of the Crank 63. This is secured to an 8″ Rod journalled in 1″×1″ Angle Brackets and carrying at its other end a second Crank that is connected pivotally to the Motor switch arm by a 4½″ Strip.

Final Assembly of the Model

The compensating beam 12 is placed in position by passing the Pin 16 through the Double Brackets 16a, which are bolted to the Girder 1 (see Figs. 3 and 4), and the Rods 15 through the end holes of the Strips 15a so that the Rods slide freely in them. The Strips 15a brace the beam and prevent it from twisting; they each consist of one 4½″ Strip and a 2″ Slotted Strip. The Sprockets 5 may now be connected to the Sprockets 10 by suitable lengths of Sprocket Chain. The base is completed with the addition of the Ring Frame (part No. 167b) carrying the sixteen ¾″ Flanged Wheels on which rolls the upper Race 3a bolted to the underside of the swivelling superstructure.

The swivelling superstructure is now lowered on to the Ring Frame, the Rod 8 passing through the Bush Wheel bolted to the upper Race. At this juncture the Socket Coupling 58 is slipped on to the Rod 8, the end of which is then passed through the Flat Girder attached to the Double Angle Strip 41. (The latter Strip has been broken away in Fig. 7 to show the gearing more clearly). The upper Race should now bed quite firmly down on the ¾″ Flanged Wheels forming the rollers and be free to turn on them, the merest touch sufficing to rotate the entire superstructure.

The A-frames (Fig. 9) are secured to the 1½″ Double Angle Strips 34 (Fig. 7) and the rear ties attached to the Angle Brackets 23a. The 1″ Triangular Plates 17 (Fig. 5) at the jib foot are pivoted on the 6½″ Rod 17a that is passed through holes in the Girders of the A-frames and held in place by Collars on the Rod; the 1½″ Strips attached to the ends of the ropes 22 forming the stays for the jib are placed also on the end of this Rod.

One end of the luffing rope is attached to a 1½″ Strip on the Rod carrying the 1″ Pulleys 24, and is taken round one of the Pulleys 19 at the jib head and back over one of the Pulleys 24. Thence it passes round the last Pulley 19 and then over the remaining Pulley 24 to the luffing winch barrel 49, on which it is

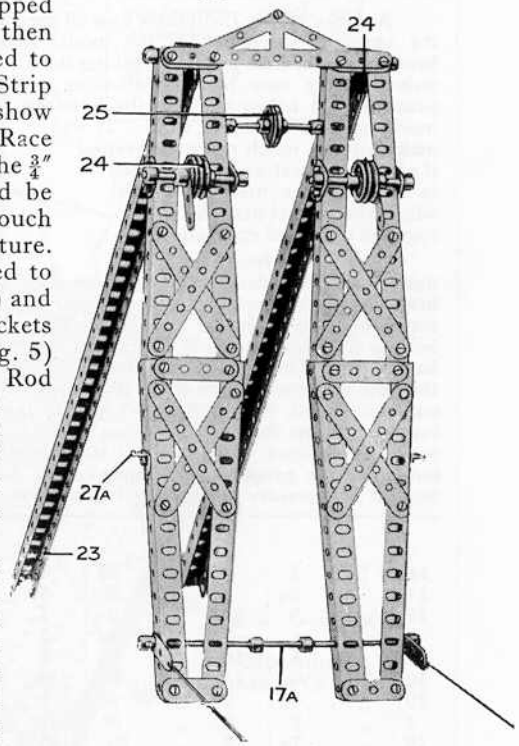

Fig. 9. The A-frames ready for attaching to the Superstructure.

secured by a Collar. The other set of luffing ropes on the other side of the jib is treated in a manner similar to that just described.

The hoisting rope is secured to the ½" Reversed Angle Bracket on the pulley block (see Fig. 10), led over the Pulley 21 at the jib head and then is rove through the sheave of the block ; thence it passes over the other Pulley 20 at the jib head and down to the hoisting winch barrel over the Pulley 25. The digging rope is secured to the digging winch barrel and is led over the 1½" Pulley 35a, the Hook 31 on its end being attached to the Sprocket Chain bridle 29 of the bucket.

Lastly the roof is placed in position. In order to accomplish this, it is necessary to remove temporarily the ties 23 of the A-frames and the Flat Girders forming the front portion of the roof. The 2" Angle Girders 27 (Fig. 8) of the roof are bolted to the Angle Brackets 27a on the sides of the A-frames (Fig. 9), and the Rods 28 are secured in the bosses of the Double Arm Cranks 28a. The front portion of the roof and the ties may now be replaced in their former positions as indicated in the general view.

The Accumulator carrier is composed of 3½" Angle Girders. To the Angle Girders forming the top, 3½" Flat Girders are secured so that their edges project outwards. It will be found that these Flat Girders will slide on the flanges of the Girders 32, so that the Accumulator may be withdrawn easily for recharging, etc. Electrical connection between the Motor and Accumulator is effected by means of two short lengths of insulated wire. Rubber covered wire will be quite satisfactory.

The chimney consists of five Sleeve Pieces and one Chimney Adaptor attached to a 6½" Rod by bolts passed through them and inserted in the set-screw holes of new-style Collars. A circular hole may be cut in the roof for the chimney to pass through, although this need not be done; the Rod only can be passed through the roof and the Sleeve Pieces arranged above and below the Plate.

General Notes on the Working of the Model

A glance at Fig. 7 will show how all the controls for the various movements of the model have been brought to a central position, making their manipulation very easy besides following actual practice, and below we describe how the model should be set to work. It will make matters much more interesting if a heap of gravel, etc., is deposited in front of the machine into which the bucket may dig as if engaged on actual excavations !

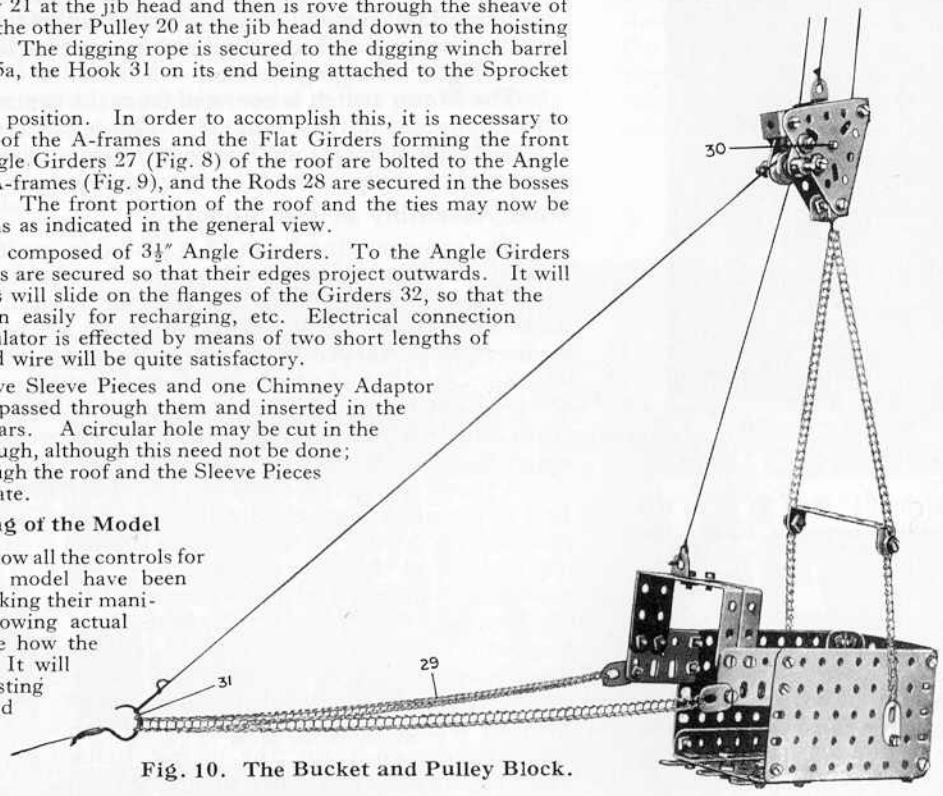

Fig. 10. The Bucket and Pulley Block.

Both the hoisting and digging winches should first be disengaged by turning the gear selector wheel 57, and the brakes of both winches manipulated so that the bucket lowers and comes to rest in a horizontal position at the far edge of the heap of gravel. The digging winch is now engaged, leaving the hoisting winch disengaged, and the Motor started by moving the Motor control handle 63. The bucket will now be dragged towards the machine, digging its way into the sand as it moves forward. By allowing the hoisting winch to run out freely a maximum cut is obtained, but by lightly applying the brake of the hoisting winch, a shallower cut results. When the end of the cut has been reached, the hoist is engaged and the digging winch disengaged. The latter is allowed to run out under the control of the brake whilst hoisting is in progress in order to keep the bucket in a horizontal position. This precaution is necessary to prevent the contents of the bucket being spilt.

It may now be necessary to slew the model so that the contents of the bucket may be deposited in a truck or elsewhere. In order to accomplish this, the gear selector wheel 57 is turned until none of the Gears 44, 44a, or 49a are in engagement with their respective Pinions on the Rod 51 ; this is "neutral." The slewing control lever 62 is then pulled upward, thereby lowering the Socket Coupling 61 and bringing the Gear attached thereto into mesh with the Worm 64 on the shaft 43 driven by the Motor. At the same time the portions of the Dog Clutch attached to the Sleeve Coupling and the Rod 60 come into engagement and turn the Rod, thus rotating the superstructure about the central pivot.

For travelling, the control lever 59 is moved toward the rear of the model. This slides the Sleeve Coupling 58 upward so that the portion of the Dog Clutch secured in its upper end engages with the other portion of the Dog on the Rod 8. The latter is thus rotated and drives the travelling wheels through the gearing shown in Fig. 3. (The Rod 51 should be left in its neutral position for the travelling or slewing movements).

As the purpose of the compensating beam to which the rear bogies are attached may not be very clear to some of our readers, we append a brief explanation.

If an object carrying a great weight and supported at each corner, such as the base of the dragline, travels over an uneven surface, abnormal stresses will be induced in it, for it may be that, occasionally, only three corners are supported, the remaining corner receiving little or no support. An illustration of this is provided when one leg of a four-legged table is packed up ; it will be observed how the table is strained and twisted when a heavy weight is placed on it. Now when a three-legged table is treated in the same way, it remains perfectly steady and no undue stresses are exhibited under these conditions. For these reasons cameras and other apparatus are mounted on tripods—really three-legged tables.

It is this principle of "three point suspension" that is employed in the Ruston Dragline and that has been so well brought out in the model. It will be seen that the base is supported by the two front bogies and at a single point—the pivot 16 of the compensating beam—at the rear. The Bush Wheels 14 with their 1" Threaded Rods form jacks, and when these are screwed down out of contact with the underside of the base, the bogies are free to rise and fall over uneven ground, thereby transmitting no undue stress to the frame and fulfilling the conditions of the three point suspension system. When the machine is in operation the jacks are tightened up, so as to distribute the load evenly when working "cross track." All four bogies are free to turn about their pivots, of course, to enable the machine to travel round curves when necessary. If the bogies were fixed the machine would be liable to derailment.

In the prototype the race supporting the swivelling superstructure is 30 feet in diameter in order to render the machine as stable as possible. In the model the Geared Roller Race gives a steadiness, in comparison, almost as great as that of the original machine, thereby affording a striking example of the efficiency of the new part.

Parts required to build the Dragline.

14	of No.	2	2	of No.	8a	6	of No.	12a	10	of No.	18a	1	of No.	26a	1	of No.	45	9	of No.	62	5	of No.	96
11	,,	2a	8	,,	8b	5	,,	12b	3	,,	18b	10	,,	27	2	,,	47	4	,,	62a	5	,,	96a
15	,,	3	21	,,	9	1	,,	13	2	,,	19b	3	,,	27a	6	,,	48	13	,,	62b	5	,,	103
5	,,	4	2	,,	9a	2	,,	13a	16	,,	20	2	,,	27b	1	,,	48a	4	,,	63	4	,,	103a
8	,,	5	10	,,	9b	4	,,	14	2	,,	21	2	,,	30	1	,,	48c	9	,,	70	6	,,	103b
10	,,	6	13	,,	9d	8	,,	15	2	,,	22	2	,,	31	14	,,	52a	9	,,	72	10	,,	103d
20	,,	6a	2	,,	9e	2	,,	15a	9	,,	22a	2	,,	32	3	,,	53a	2	,,	76	2	,,	103f
4	,,	7	6	,,	9f	3	,,	16	1	,,	23	555	,,	37	2	,,	55a	8	,,	77	2	,,	103g
16	,,	7a	18	,,	10	5	,,	16a	5	,,	24	8	,,	37a	1	,,	57	1	,,	79a	1	,,	103h
2	,,	7b	20	,,	11	1	,,	16b	5	,,	25	14	,,	38	3"	,,	58	2	,,	82	3	,,	103k
26	,,	8	22	,,	12	14	,,	17	10	,,	26	6	,,	40	82	,,	59	57"	,,	94	22	,,	111c

2	of No.	113	2	of No.	160																		
6	,,	115	1	,,	162																		
1	,,	125	5	,,	163																		
8	,,	126	2	,,	164																		
2	,,	126a	1	,,	167																		
2	,,	133	2	,,	170																		
1	,,	136	1 4-volt Electric Motor																				
2	,,	144																					
1	,,	147a																					
3	,,	147b	1 Accumulator 8 amp.-hr.																				
1	,,	148																					