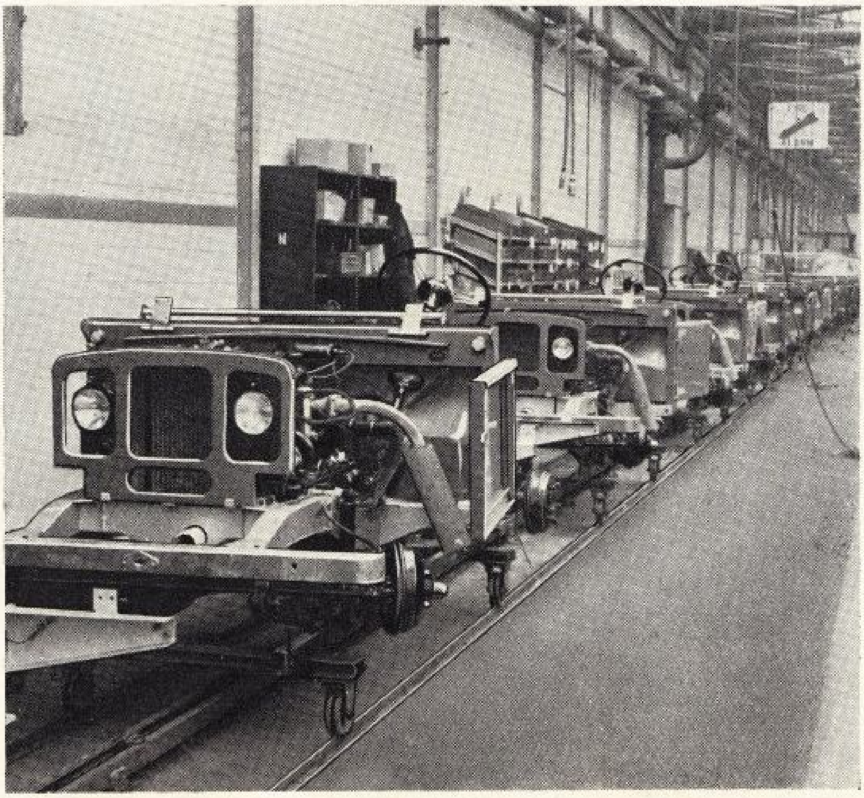
Production of the Land-Rover

Welding and Assembly Operations on a Multi-purpose Vehicle



A Section of the Main Assembly Line for the Land-Rover

The Land-Rover has been developed to meet the demands of agriculture and industry for a multi-purpose vehicle. Made by the Rover Company, Ltd., of Birmingham, it is fast and economical on the road, and, with its four-wheel drive, will ford streams and operate under cross-country conditions which would be impossible for an ordinary vehicle.

On the farm it will carry out many of the duties normally performed by a tractor, and can be used for the transport of heavy loads over ploughed fields or rough land. By way of the power take-off at the rear it will provide the drive for a threshing machine, elevator for rick building, chaff cutter, circular saw, and other machines, while a centre power take-off can be provided for driving an air compressor for tree spraying, and for operating portable milking machines and other equipment.

Industrial uses of the Land-Rover include the moving of heavy machinery, delivery of goods, driving of mobile welding plant, and provision of power in emergency. With a suitable body it may be used as a station wagon, estate car, or school or hotel bus, providing comfortable seating accommodation for seven adults.

A view of the vehicle arranged for general farm use is given in Fig. 1, while Fig. 2 shows the chassis. The side and cross members are of box section, seam welded, and form an assembly of exceptional rigidity. A differential similar to that in the rear axle is provided for the front axle, and the drive to the front wheels is transmitted through a free wheel and constant velocity universal joints, totally enclosed. Semi-elliptic springs and tubular shock absorbers are fitted.

The swept volume of the four-cylinder engine is 1,595 c.c., and it gives a maximum output of 50 b.h.p. A 3-bearing crankshaft of the counter-balanced type is fitted, and the overhead inlet valves are operated by rockers and push rods from the camshaft, whereas the side exhaust valves are operated by rockers which are in direct contact with the camshaft. The aluminium pistons have inverted V-shaped heads to suit the special form of the combustion chambers.

The main gearbox provides four forward speeds and reverse, while an additional transfer box increases the number of forward speeds to eight, the drive being transmitted through a single dry plate clutch. The detachable disc wheels are fitted with 16 x 6.00 heavy-duty traction type tyres.

The body and other sheet metal work of the Land-Rover is of light alloy, which is not subject to corrosion under normal conditions, and all external steel fittings are galvanized as a protection against rust. Although Fig. 1 shows the vehicle with an open body, a hood is provided for protection against the weather.

Two factories are concerned in the production of the Land-Rover, namely the main factory at Solihull, Birmingham, where the assembly and finishing lines for Rover cars are installed, and the engine works a short distance away at Tyseley. The chassis frame for the Land-Rover is built at Solihull, together with the various body

Fig. 1. The Land-Rover arranged as a General Purpose Farm Vehicle. A Hood is Provided to Afford Protection for the Passengers and the Load

works, where the completed engine and gearbox units are assembled and tested before being sent to the Solihull factory. Before it leaves the latter factory, each Land-Rover is tested on a special track, under conditions as severe as any which are likely to be encountered in service.

The output at present is about 55 vehicles per day. It should be noted, however, that the factory is not yet operating according to the ultimate plan. Equipment and conveyors are still being awaited which, when in operation, will make it possible to double the present daily production figure.

The main chassis members of the Land-Rover are made from sheet steel of 14 S.W.G., and, as already mentioned, are of box section. The various sheet metal components are blanked in the press shop, using simple tools, and are then passed to the chassis units, and the vehicle is assembled and completed on the main assembly line, a view of which is given in the heading illustration on page 871. The machining of the engine and other mechanical parts is carried out at the Tyseley

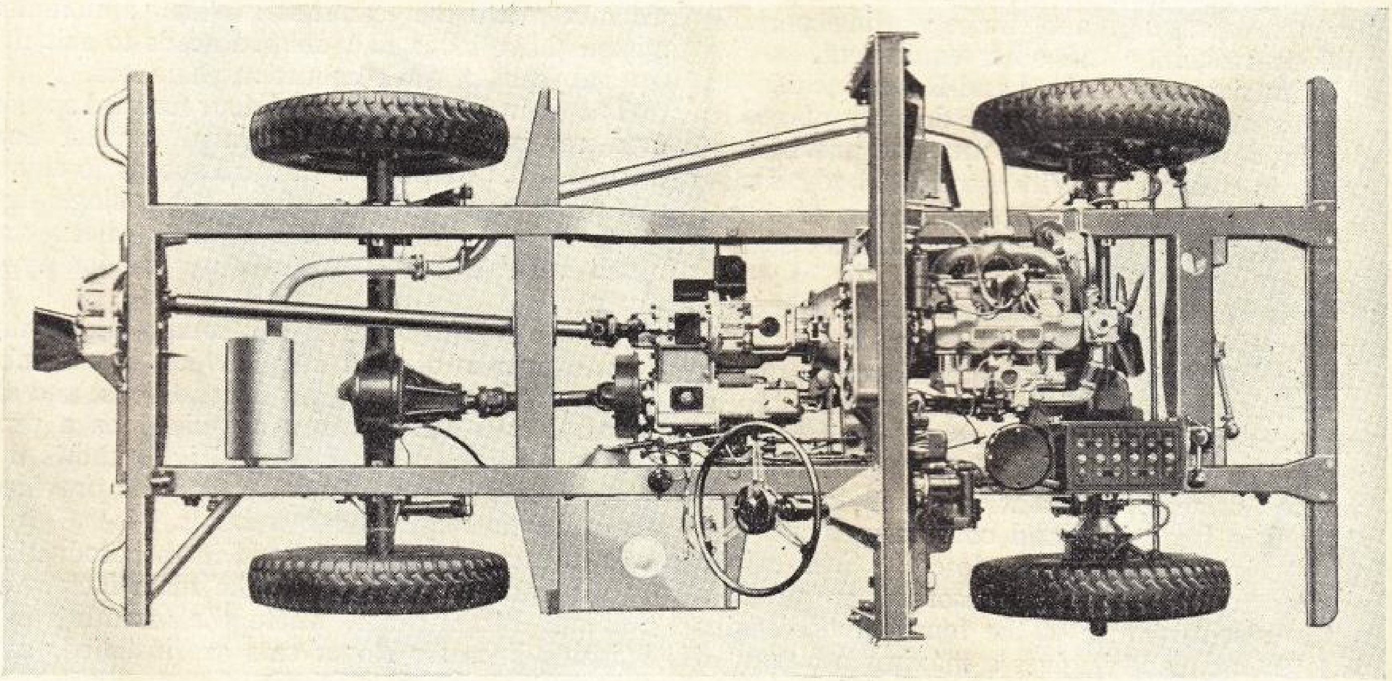


Fig. 2. Plan View of the Chassis of the Land-Rover showing the Engine, Gear Box, and Transfer Gearbox. A Power Take-off is provided for Driving various types of Machinery

frame welding shops, where they are first tack welded together with the aid of special locating jigs, in preparation for seam welding.

Welding operations in the construction of the main side frame members commence with tack welding the bottom plate to the two side plates, using the jig shown in Fig. 3. The side plates are spaced by the block *A*, on which they are located by means of plungers, engaging holes punched during the initial blanking operation. After the side plates have been positioned, the bottom plate *B* is placed on them, and the three plates are then held together by quick-action toggle clamps, as shown.

The jig is enclosed in a cubicle, as are the other welding jigs in the shop, and the tack welding is performed by two operators who work from opposite ends of the assembly. Each is provided with a portable eye shield, and, as an additional protection, a plate suspended above the jig is lowered before welding commences. This has an aperture in its lower edge in order that it may straddle the assembly and thus effectively separate the two welders.

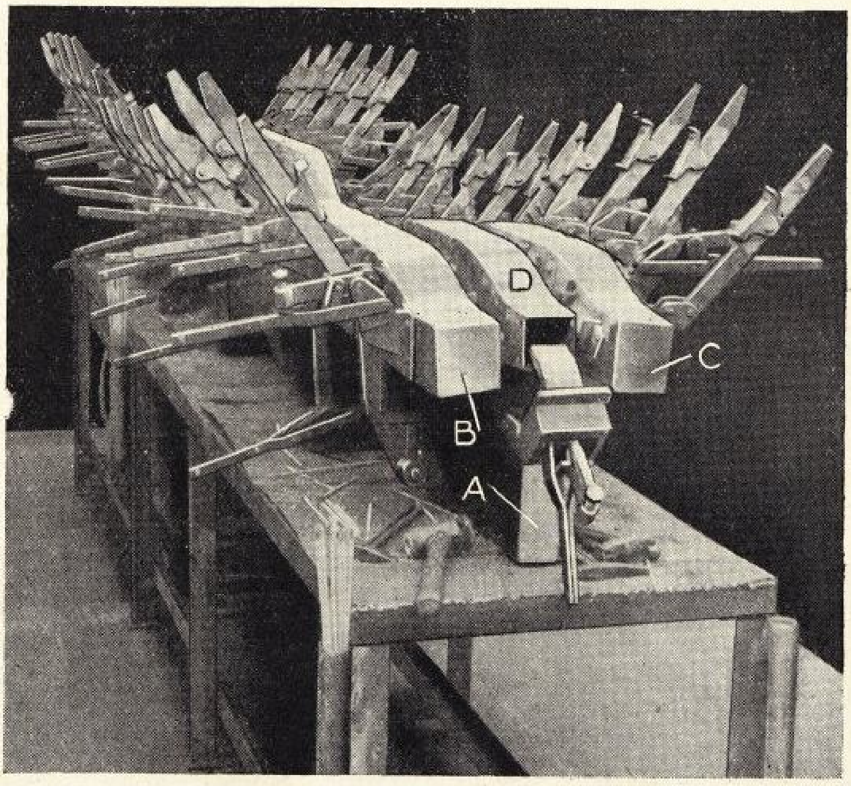


Fig. 4. Magnetic Jig employed for Tack Welding the Top Plates to the Side Plates of the Box-type Main Chassis Frame Members. Electro Magnets serve to Hold the Side Members of the Jig to the Work

After the bottom plate has been tack welded to the side plates as described, an internal bracket is secured in position, and the assembly is then placed in the magnetic jig shown in Fig. 4, in which the top plate is tack welded to the side plates. This jig has a block *A* on which the tack welded side and bottom plate assembly is placed, and two hinged side members *B* and *C*. The illustration shows the hinged members in the withdrawn or loading position. With the work in position, they are swung inwards to engage the side members of the assembly. An electric current is then switched on to energise a series of built-in electromagnets. Thus the side members of the assembly are held upright

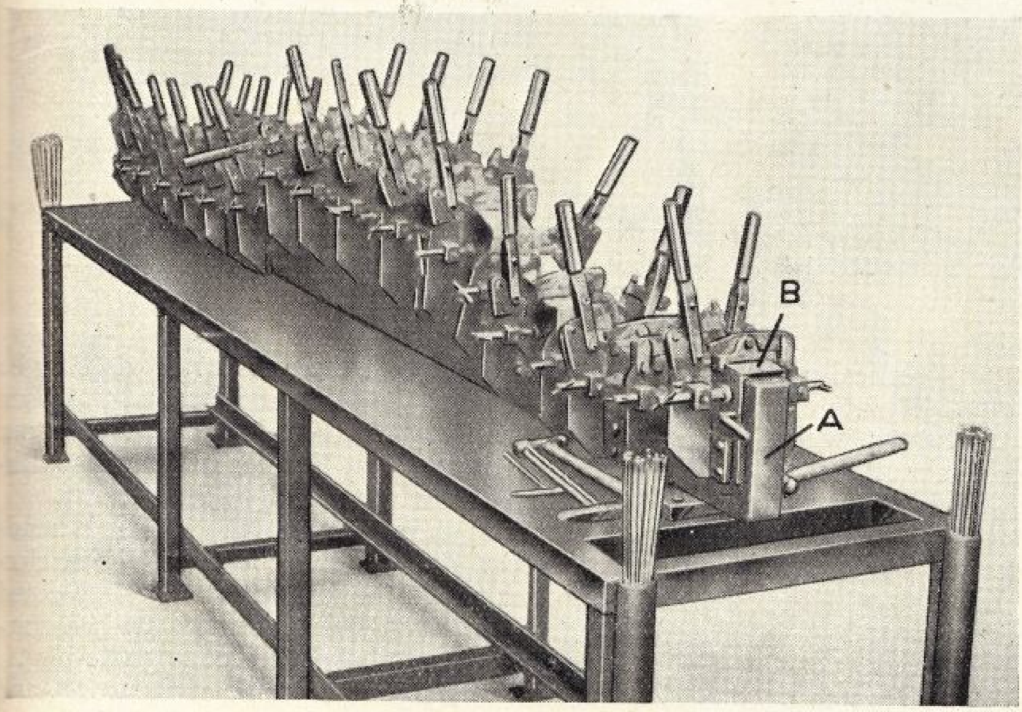


Fig. 3. Tack Welding Jig in the Chassis Frame Section of the Works. It is used for Assembling the Bottom Plates to the Side Plates of the Box-type Main Chassis Frame Members. Toggle Clamps hold the Members together

while the top plate D is placed in position and secured by toggle operated clamps. At each end of the assembly a clamp engages the bottom plate to hold it to the block A.

Tack welding is carried out by two operators in the same manner as for the previous stage illustrated in Fig. 3, a protecting plate being again used to safeguard the workers who operate with the usual portable eyeshields.

For the seam welding of the chassis side frame members a special metallic arc welding machine shown in Fig. 5 and 6 was supplied by Fusarc, Ltd. This machine operates automatically after it has been started up, and has a table on which there is accommodation for two side frame member assemblies, placed end to end. The welding is carried out with the electrodes vertically above the points of abutment of the side plate and the top and bottom plates, the two seams, which are in the same plane, being welded simultaneously at a speed of approximately 64 in. per minute, employing a current of about 250 amps.

The two tack welded side frame members are placed on the table with their forward ends in contact with one another and engaged by a quick release clamp, while the rear ends are positioned by stops. The quick release clamp is of the double type, and allows the two chassis frame members to be clamped individually. With this arrangement the two members may pass under the welding heads one after the other without there being any interruption of the welding process. The inverted channel member which forms the welding table runs on rollers on a bed 50 ft. long, the table being driven at the required welding speed by a variable-speed geared motor unit which operates through a double clutch. A secondary clutch brings into operation a high speed reversing motor thereby enabling the work table to be rapidly traversed back to its starting point at the conclusion of the operation.

The automatic arc welding heads are mounted on columns which are disposed centrally in relation to the bed, and are carried by roller-bearing-mounted turrets with adjustable spring loading to allow the electrodes to be brought into position over the seams to be welded. Snap catches are provided in order that the welding heads may be aligned parallel to the track and clear of the work table for changing electrodes, and carrying out adjustments, and when the heads are thus withdrawn current is automatically switched off.

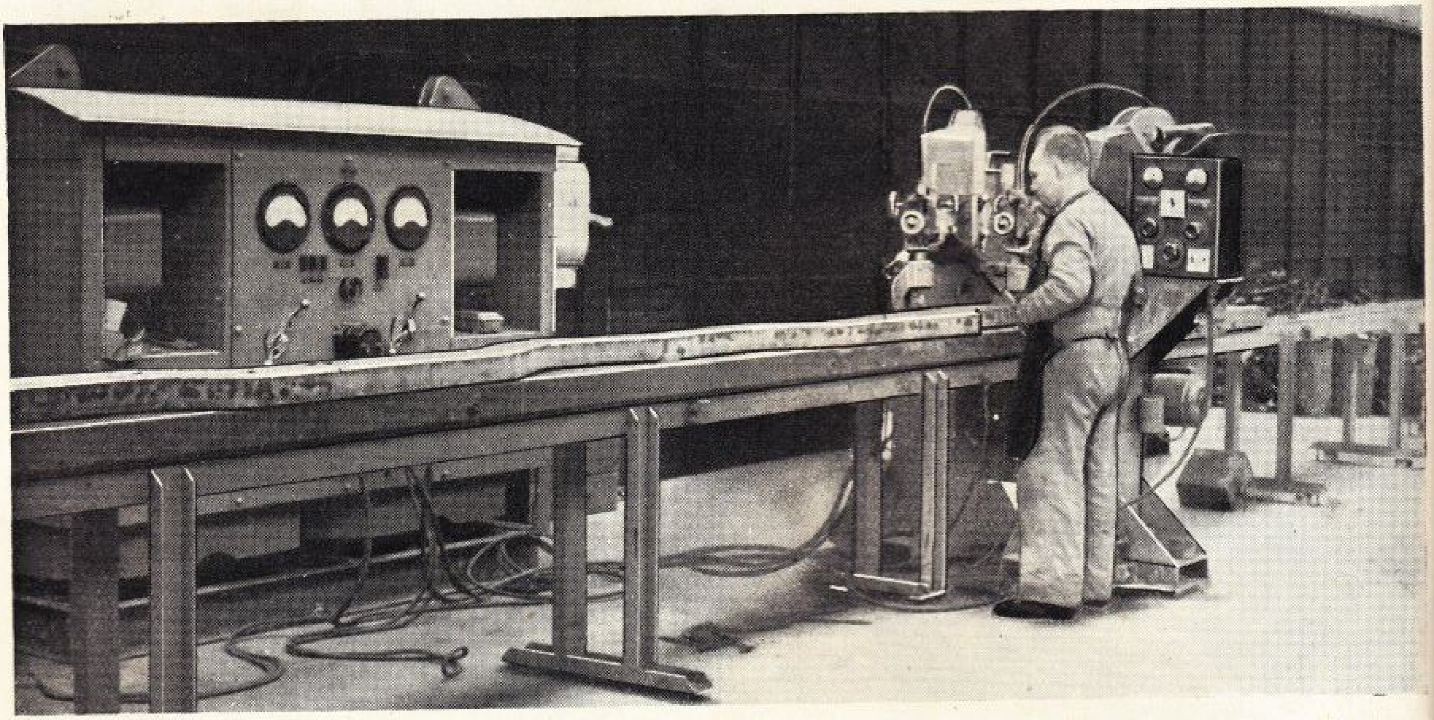


Fig. 5. Automatic Seam Welding Machine for Main Chassis Frame Members. Two Seams are dealt with Simultaneously, and two Main Frame Members are accommodated on the Table of the Machine, these being Placed End to End

The nozzles employed on the welding heads are of special design to accommodate the electrodes which are in the form of small gauge cored welding wire. Each nozzle is fitted with a tracing head, having a phosphor bronze guide pin A, Fig. 6, which engages the profile of the work, and maintains the nozzle in the correct relative position as the operation proceeds. A handwheel B enables the electrode to be correctly aligned with the seam.

All controls are centralized on a panel at the right-hand side of the operator, as shown in Fig. 5. Thus one man can control the entire welding operation, a labourer being employed to load, turn over, and unload the frame members as required.

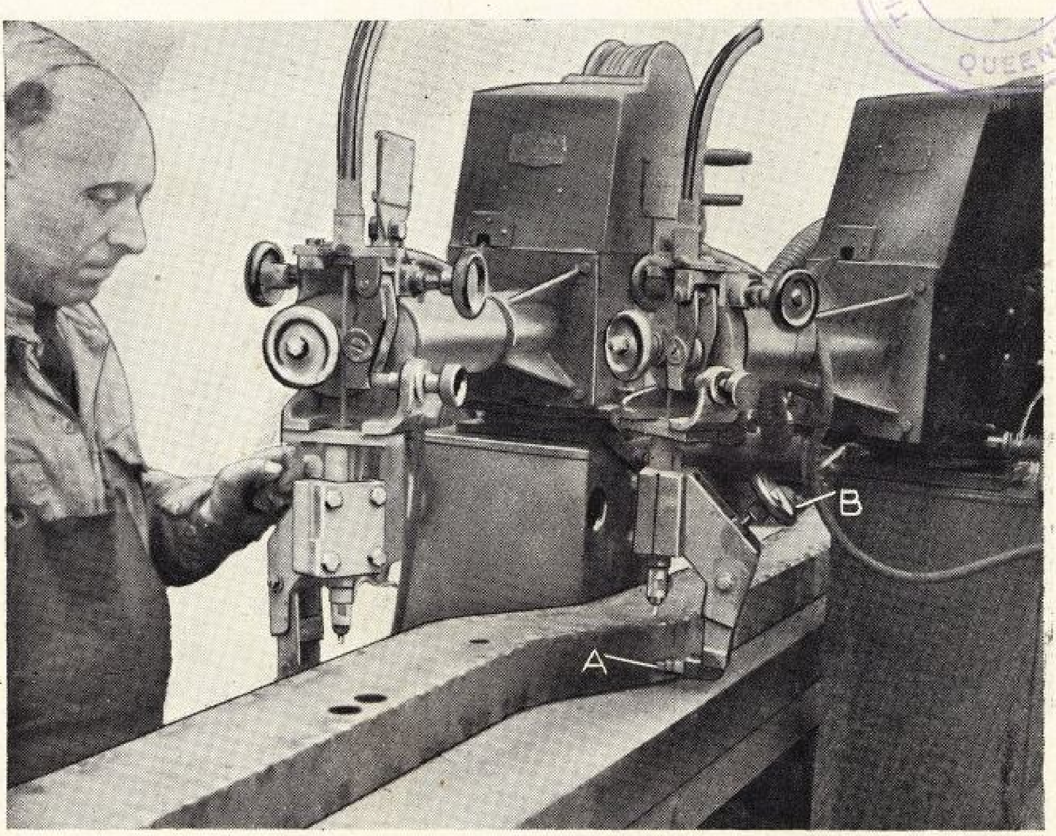


Fig. 6. Close-up of the Automatic Seam Welding Machine for Main Chassis Frame Members. The Machine has two Nozzles which are Fed with Electrode Wire from Coils

At the commencement of the welding operation the table is at the extreme end of the bed. Guide pieces on the table direct the electrodes to the end of the first frame member, and welding continues along the two members as they are fed under the welding heads. After the first frame member has passed under the electrodes, one jaw of the quick acting clamp is released, and the seam welded member is turned over and reclamped. When the second frame member has, in its turn, been seam welded the high speed reversing motor is engaged, bringing the table back to the starting position again. Welding then commences on the first member, which has already been turned over, while the second member is being unclamped and inverted. Welding continues from end to end of the two members as before. With this arrangement there is a minimum of delay for loading and unloading.

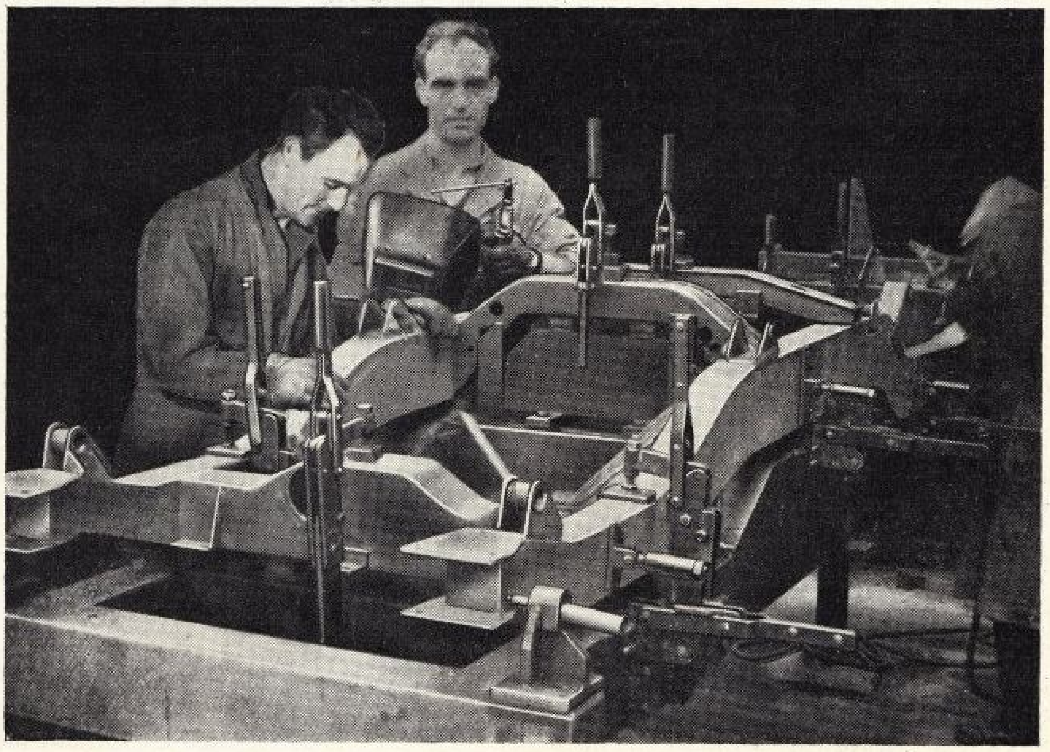


Fig. 7. The Seam Welded Side and Cross Members of the Chassis Frame are Tack Welded together with the Aid of a Special Jig. Quick Acting Clamps Secure the Various Members

The time required to complete the welds over the full length of the bed is approximately 5 minutes, and, taking into account the reversing time necessary, the output of the machine is five pairs of frame members per hour.

The speed of the welding wire through the nozzles can be varied as required, and averages 18 in. per minute. Drums carry the wire, which is fed to

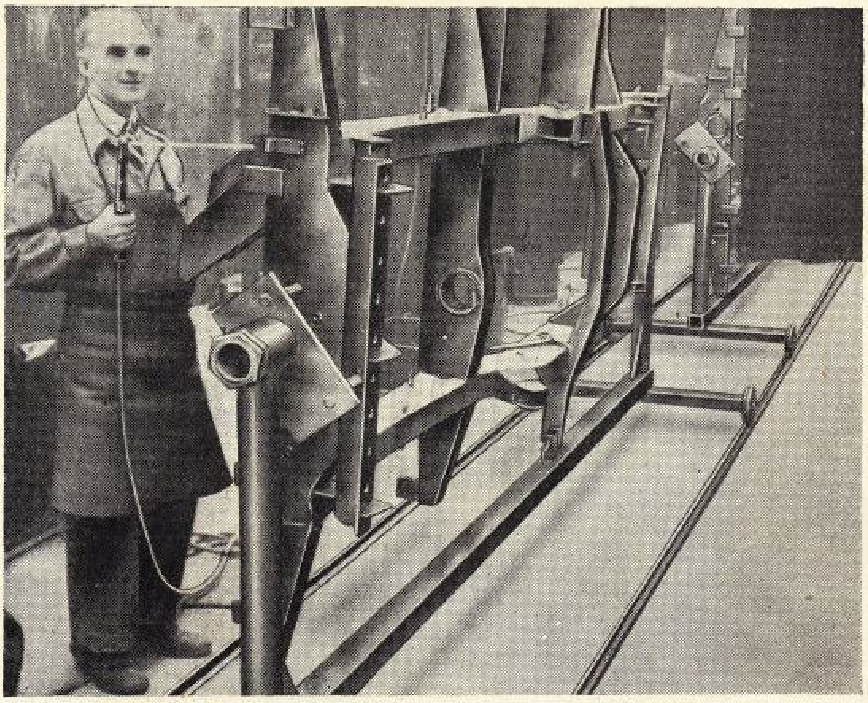


Fig. 8. The Welding Work on the Chassis Frame is Completed on a Track, the Frames being so Mounted on Special Carriages that they may be Turned to Suit the Convenience of the Operators

the nozzles, by rolls of appropriate form, through guide channels, as shown.

After seam welding, the main chassis members are cleaned with rotating wire brushes, and are then placed in jigs to receive various brackets, which are welded into position. Suitable means are provided for the location of the brackets during tack welding, the final seam welding being carried out after removal of the work from the jigs. Portable electric tools fitted with emery discs are employed for final cleaning.

The box-form cross-members of the chassis frame are tack welded in special assembly jigs in much the same manner as the main longitudinal members, and are then removed from the jigs for seam welding, after which they are cleaned with rotating wire brushes and emery discs.

After completion, the longitudinal and cross frame members are tack welded together in the jig shown in Fig. 7. The longitudinal members are located by plungers and a number of fixed pads, while positioning pieces locate the cross members, as shown. Quick-action toggle-operated clamps are employed to hold the various members in place.

In the adjoining cubicle, a jig is provided for the tack welding of the body mounting brackets, the petrol tank carriers, and other fittings, location being taken, in this instance, from the tail board hinge brackets. When all the various brackets have been attached, the chassis frame is ready to be passed to the main assembly line.

Wheeled cradles, one of which is shown in Fig. 8, are used to carry the frames on the main assembly track. The frame is supported in such a manner that it may be turned about its longitudinal axis, and locked in any position to suit the operators' convenience. In order to prevent distortion of the frame by seam welding, the welding work is carried out at ten different stations, the various operations being performed in separate cubicles. The latter have curtains which can be pulled aside to allow the carriages to be passed from station to station. In each cubicle certain seams are welded, and the division of the work has been carefully studied to enable the best results to be obtained. The frame is attached to the end brackets of the carriage by the front and rear bumper brackets, as shown.

At certain stations in the chassis frame assembly line various drilling operations are carried out, for which jigs, suspended from over-

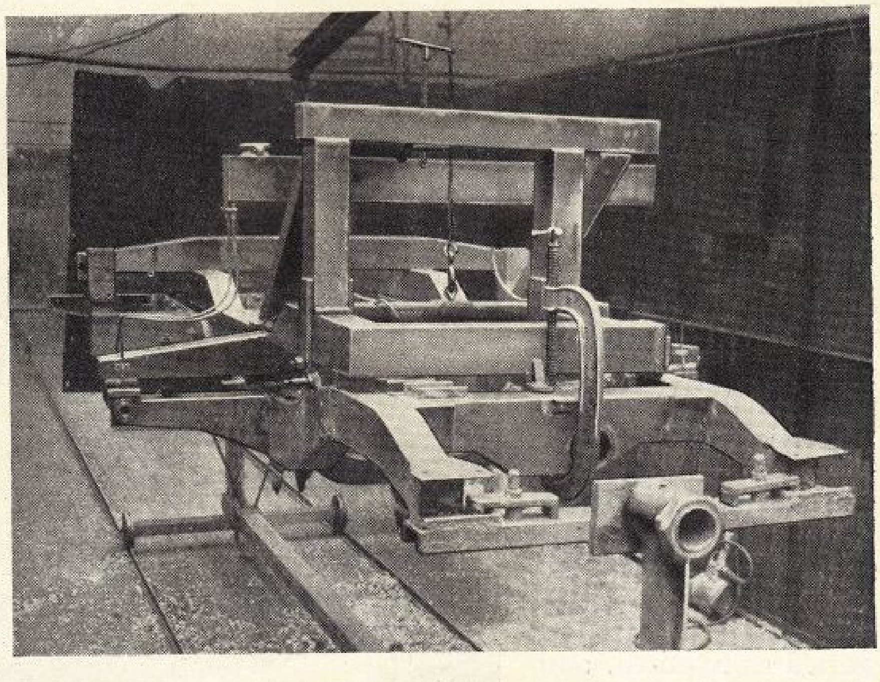


Fig. 9. Drilling Jigs are suspended over the Chassis Frame Line at the Appropriate Points, and are Lowered on to the Frame as required for Drilling the Various Holes.

head runways, are lowered on to the frame and secured in position. Fig. 9 shows the jig used in connection with the drilling of the engine mounting holes, the scuttle fixing holes, and various other holes in the assembly. The frame is locked in the horizontal position before the jig is lowered on to it and secured. A feature of the jig is the provision of piping to convey coolant to the drills, which are operated by portable tools.

The drilling of one of the spring brackets is shown in Fig. 10. Here again the jig is suspended from an overhead runway, and lowered on to the frame. A heavy box-form welded bracket carries a feed screw whereby the necessary axial pressure is applied to the portable pneumatic drill. The jig is located by fixed pads and withdrawable plungers.

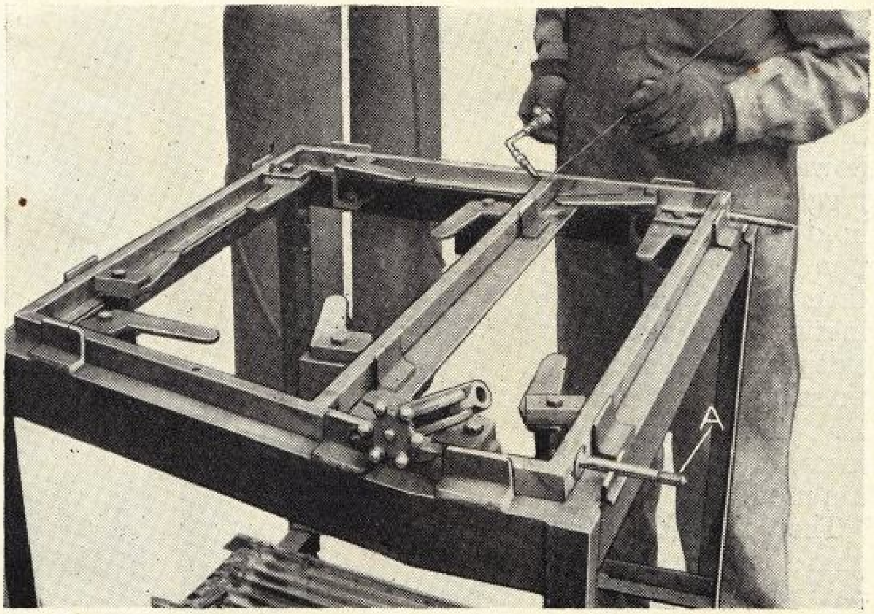


Fig. 11. Gas Welding is Employed for Assemblies Built-up from Comparatively Thin Sheet Material. The Illustration shows a Typical Assembly Jig with Cam Type Clamping Levers

When all the welding and drilling operations have been completed, the welds are cleaned by chipping with portable tools, and the frame, still in position on its carriage, is passed into a spray painting booth where it receives a coat of rust-resisting primer. The booth is of modern construction with effective side lighting, and a water washed floor, towards which the air is sucked by fans. On leaving the booth, the work passes through a drying oven which is maintained at a temperature of 140 deg., and thence into a second booth where the final coat of synthetic paint is applied. From this booth the work is carried through an infra-red drying oven, in which it remains for a period of 9 minutes. After withdrawal from the oven, the work is allowed to cool before being removed from its cradle and sent to the main chassis assembly section.

A portion of the welding department is laid out for operations on sub-assemblies of comparatively thin gauge material, for which gas welding is employed. Fig. 11 shows a typical assembly jig. The assembly comprises two longitudinal and three cross members, and to one of the latter bolts *A* are fitted and welded in position. The bolts are positioned by rests while the various box section members are located by fixed stops. Cam action clamps hold the various members against the fixed stops.

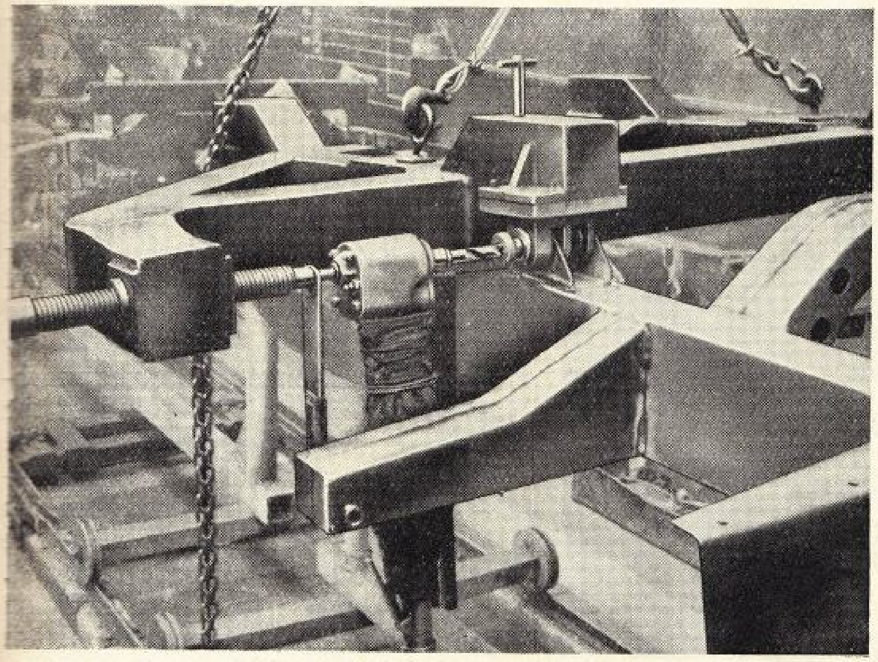


Fig. 10. Pneumatic Drill positioned for the Drilling of One of the Spring Mounting Brackets. The Jig is Lowered on to the Chassis Frame from an Overhead Runway

The various units of the body for the Land-Rover are made in sub-assembly sections which feed the main assembly shop. The light alloy pressings for the front mudguards, as received from the press shop, are passed through rolls for bending, prior to the flanging operation on the machine shown in Fig. 12. The illustration shows a flanged mudguard about to be removed from the machine. For flanging, the curved pressing is placed on the block *A*, where it is positioned by four hinged stops *B*, which are subsequently lowered to clear the

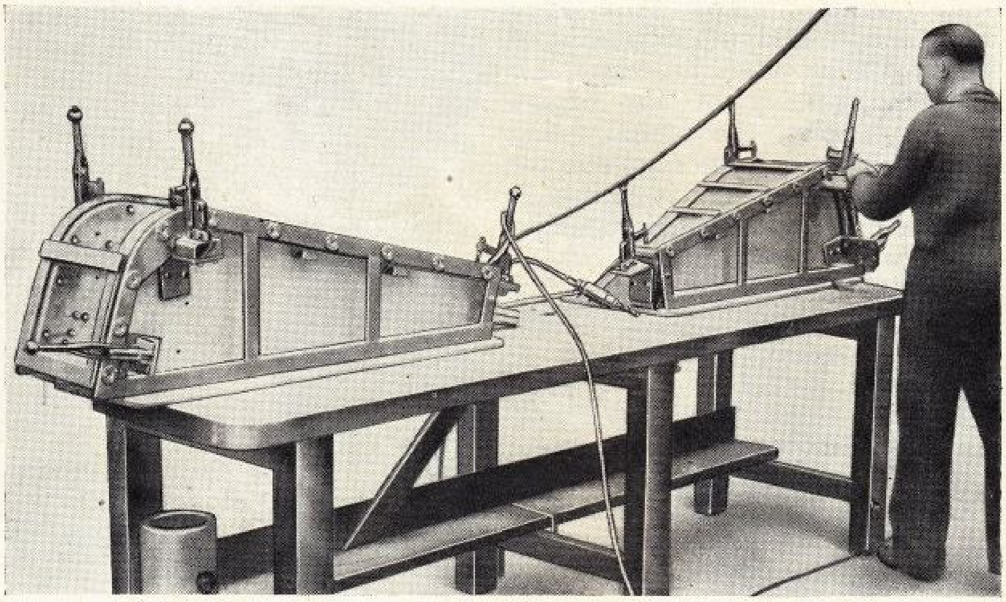


Fig. 13. A Pair of Jigs of Opposite Hand for Drilling the Holes in the Flanges of the Mudguards. Portable Electric Tools are Employed

work, as shown. Operation of a handle at the end of a screwed shaft brings the upper tool *C* down on to the work by toggle lever action, to hold it securely in position. The flanges are then formed by hammering the projecting sides and ends of the pressing over the block *A*. Two similar fixtures, of opposite hand, are used.

The flanged mudguard is next drilled, a pair of jigs of opposite hand being provided for this purpose, as shown in Fig. 13. A centre block positions the work between the jig side frames, and a top frame is placed on the pressing, and secured by quick-action toggle clamps. Electric hand tools are used to drill the holes.

In one of the assembly sections, the various aluminium alloy pressings are joined together by spot welding, using Sciaky welding machines of both fixed and portable types. Jigs position the various components, which are first degreased in an I.C.I. degreasing tank. Rivets are employed where spot welding is impossible, and all bolts required in the assemblies are fitted with retainers.

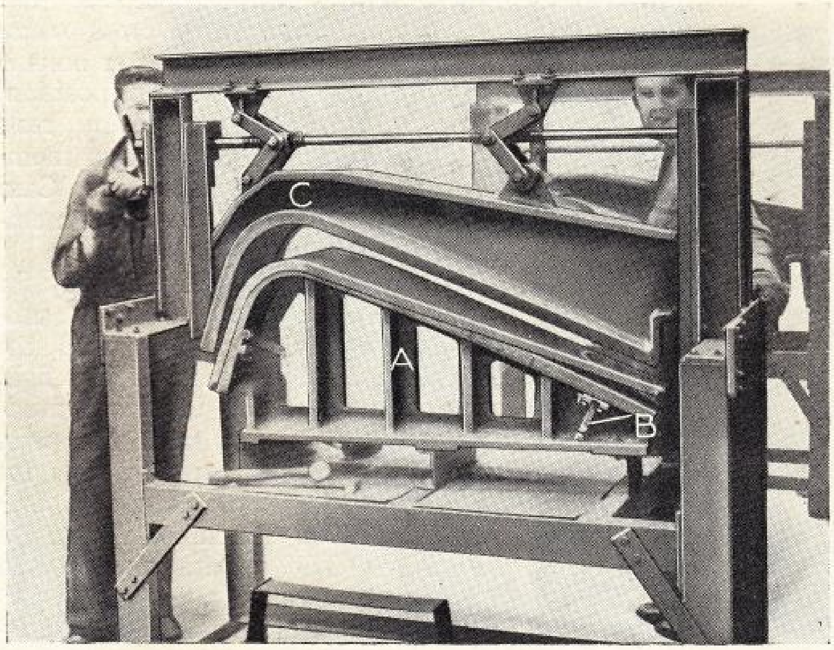


Fig. 12. Fixture for Holding one of the Front Mudguards while the Flanges are produced by Hammering. The Upper Tool is Operated by a Handle through a system of Toggle Levers

Simple jigs serve for positioning the various components for welding, and a typical example, for one of the smaller assemblies, is shown in Fig. 14. This particular assembly is the centre cover panel on which the centre seat is eventually mounted. Angle pieces position the pressings at the four corners of the panel, while the cross member is held by spring fingers. The jig has a base of plywood, and is loaded on a table adjoining the spot welding machine.

The main assembly line extends from one end of the assembly shop to the other and back again, there being two parallel tracks for the cradles on which the vehicles are built, with transfer platforms connecting the tracks at the two ends. As a vehicle is completed and removed from the track, the empty cradle is transferred from the finishing track to the starting end of the adjoining track ready to receive the next chassis frame. The sub-assembly sections adjoin the main assembly line at the points where the various sub-assemblies are required.

The axles are first positioned on the cradle, after which the chassis frame is lowered on to the springs and the shackle bolts inserted. At this point also the differential housings are filled with oil. As the

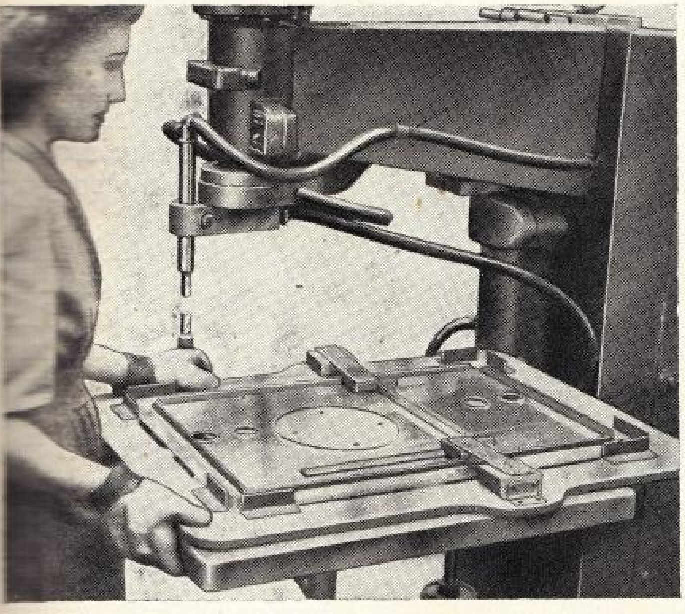


Fig. 14. One of the Simpler Welding Jigs for Small Sub-Assemblies in Aluminium Alloy. The Spot Welding is Carried Out on the Machine which Adjoins the Jig Loading Table

cradle moves along the track the shock absorbers and brake tubes are fitted and the brake tubes are bled. The engine and gear box unit follow, together with the steering gear, and the foot controls are fitted prior to lowering the scuttle on to the chassis as a complete unit. Before the chassis is transferred to the second or return track, all the electrical work is completed.

On the return track the body assemblies are mounted, together with such details as the wind screen and floor plates, and finally the wheels are bolted in position, the vehicle being then ready to be driven away for testing.

In further articles to be published in forthcoming issues of MACHINERY, the production of various components for the Land-Rover will be described, including the cylinder block, which has chromium-plated bores, pistons, brake drums, steering ball joint body, and rear wheel bearing housings.

FRENCH STEEL PRODUCTION in the first quarter of this year averaged 746,000 tons per month. For the whole of 1948 the average was 594,000 tons.

Multiple-action Press Tool for Air Cleaner Casings

The part shown in Fig. 1, made from 0.024 in. thick mild steel, forms the shell for one of the many types of air cleaner made by A.C. Sphinx Spark Plug Co., Ltd., Dunstable, Beds. In connection with its production an interesting tool has been designed for forming, drawing, piercing and plunging at one stroke on a Taylor & Challen No. 4½ double-action, toggle drawing press fitted with a Worson pneumatic die cushion arranged with special control gear.

This tool, together with a finished part, is shown in Fig. 2, while sectional views through the centre of the punch and die are given in Fig. 3. It may be noted that casings of various lengths, up to 14 in., are made on the one tool. The blanks, 14 23/32 in. wide, and of the length required, are cut on a guillotine, and, prior to forming, three separate operations are performed on light power presses and hand presses, these comprising notching the corners, piercing four holes, and embossing the maker's name and other lettering.

On the forming tool, the blank is located at the corners on four spring-loaded, pivoted latches *A*, Fig. 2 and 3, these being retracted automatically as the part is formed and returned by the springs up to stop pins as indicated at *B*. In operation, the mild steel blank holder *C*, fastened to the outer press slide, first moves down and forms the sheet over the floating pad *D*, which is also of mild steel, and is guided by case-hardened and ground steel pillars *E* in the mild steel body *F*, and urged upwards by strong coil springs, as shown. This movement is limited by two headed

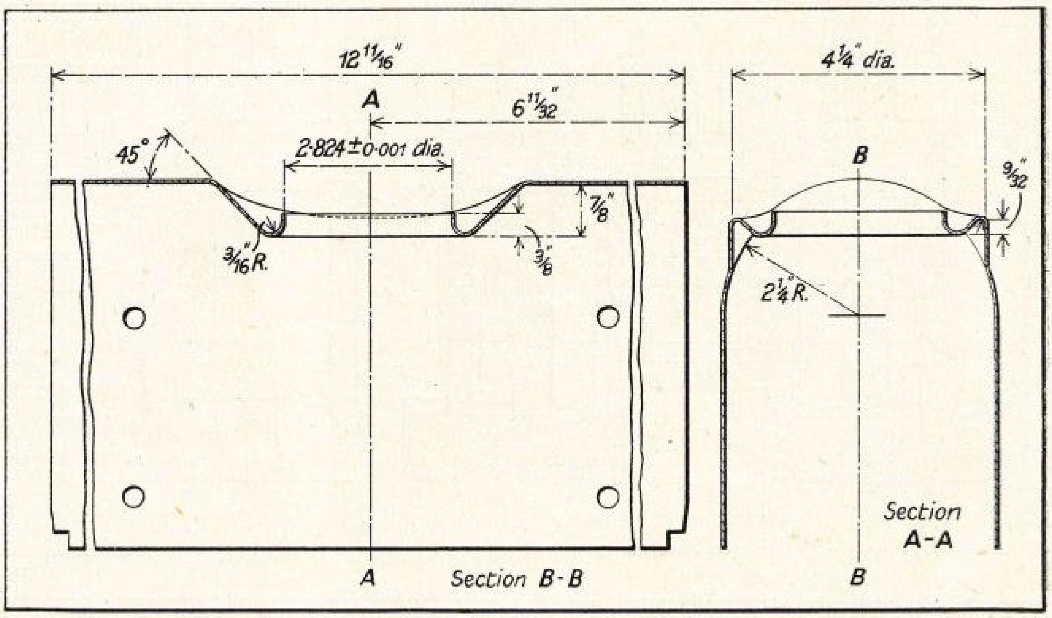


Fig. 1. The Air Cleaner Shell which is Formed, Drawn, Pierced and Plunged at One Stroke of a Double-acting Press

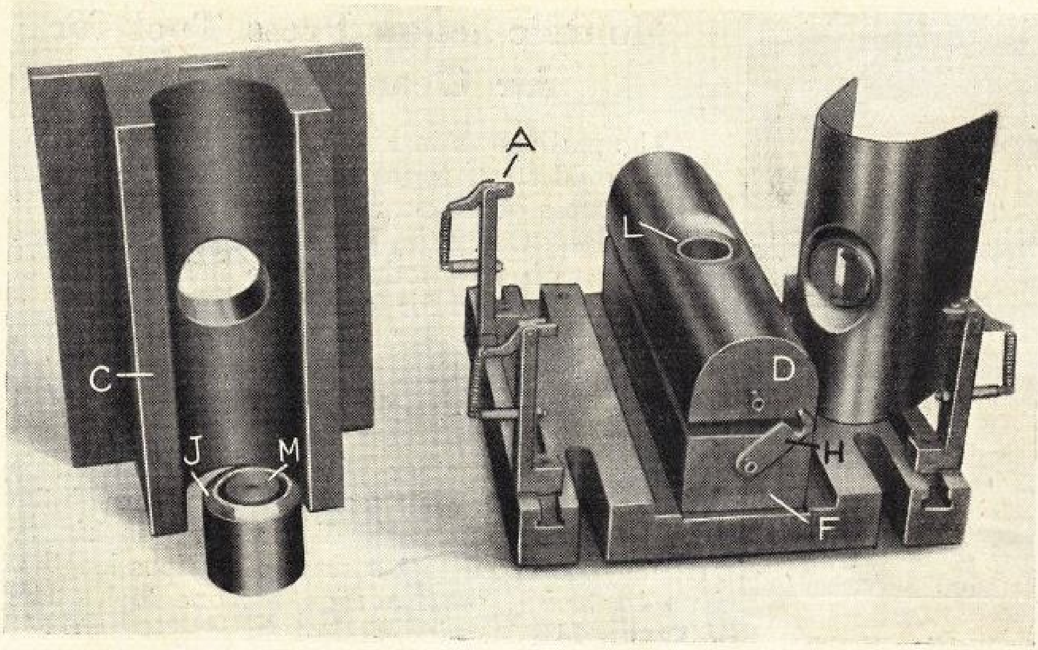


Fig. 2. The Multiple-action Tool used for the Operation on the Shell

are of cast steel, hardened and polished. At the bottom of the stroke of the inner slide, the pad bears against the top face of the body *F*, as shown in Fig. 3. At this stage, the pneumatic die cushion, which so far has been inoperative, comes into use, the valve gear being controlled by a cam drum driven by chain from the press crankshaft. Upon admission of air to the cushion cylinder, the hardened and ground steel piercing die *L* moves upwards and pierces the centre hole in conjunction with the punch insert *M*, the body N of which is fastened by cross dowels within the drawing punch. The cutting face of this punch insert is level with the lower edge of the drawing punch so that it also functions as part of the latter.

A radius is provided at *Y* on the outer edge of the piercing die, and continued upward movement of the latter results in plunging of the hole as shown. The air cushion is exhausted to retract the die just as the floating pad is returned by its springs to the top position upon the upward stroke of the press slides.

studs *G*, and for convenience when tool setting, a keep latch *H* is provided at each end of the tool. The blank holder *C*, it may be noted, is machined with a rough inner surface in the transverse direction to grip the blank and so minimize longitudinal movement during the subsequent stages of the operation.

When the part has been formed by the blank holder round the floating pad, the inner slide of the press descends and the metal at *X*, Fig. 3, is drawn down by the action of the punch *J* in conjunction with the pad insert *K*, both of which

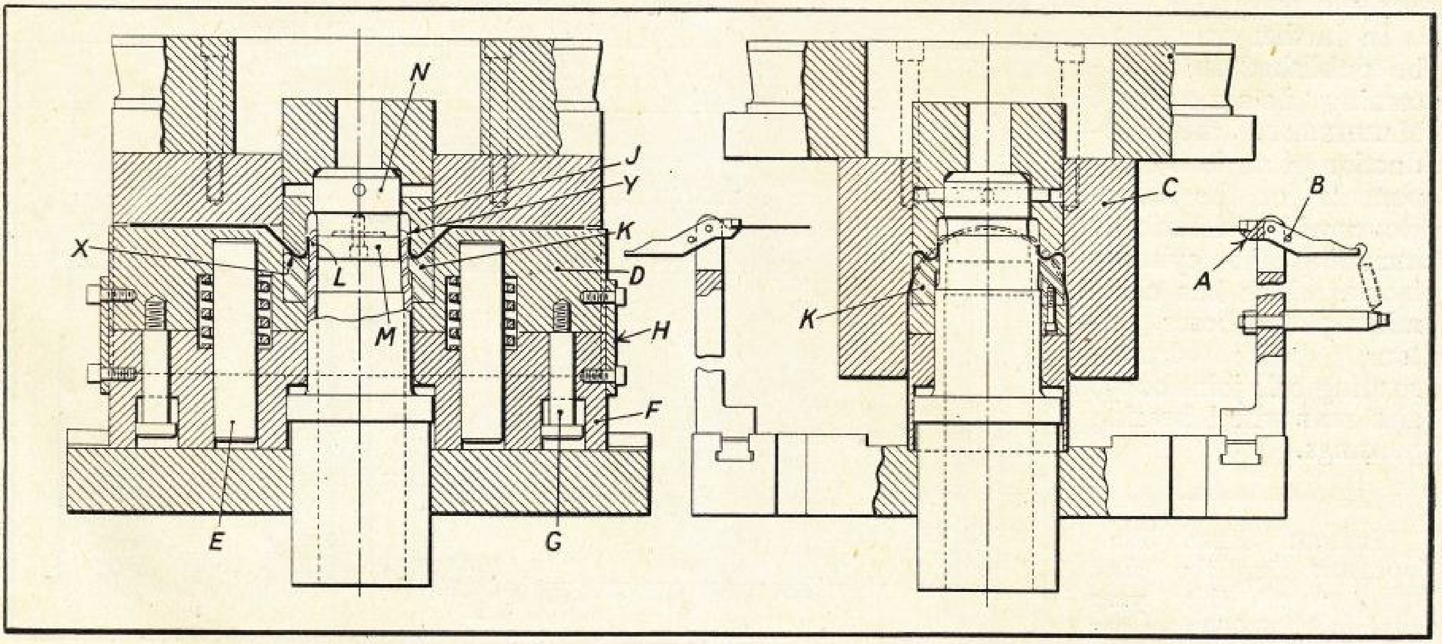


Fig. 3. Sectional Views through the Centre of the Tool for Forming, Drawing, Piercing and Plunging the Air Cleaner Shell