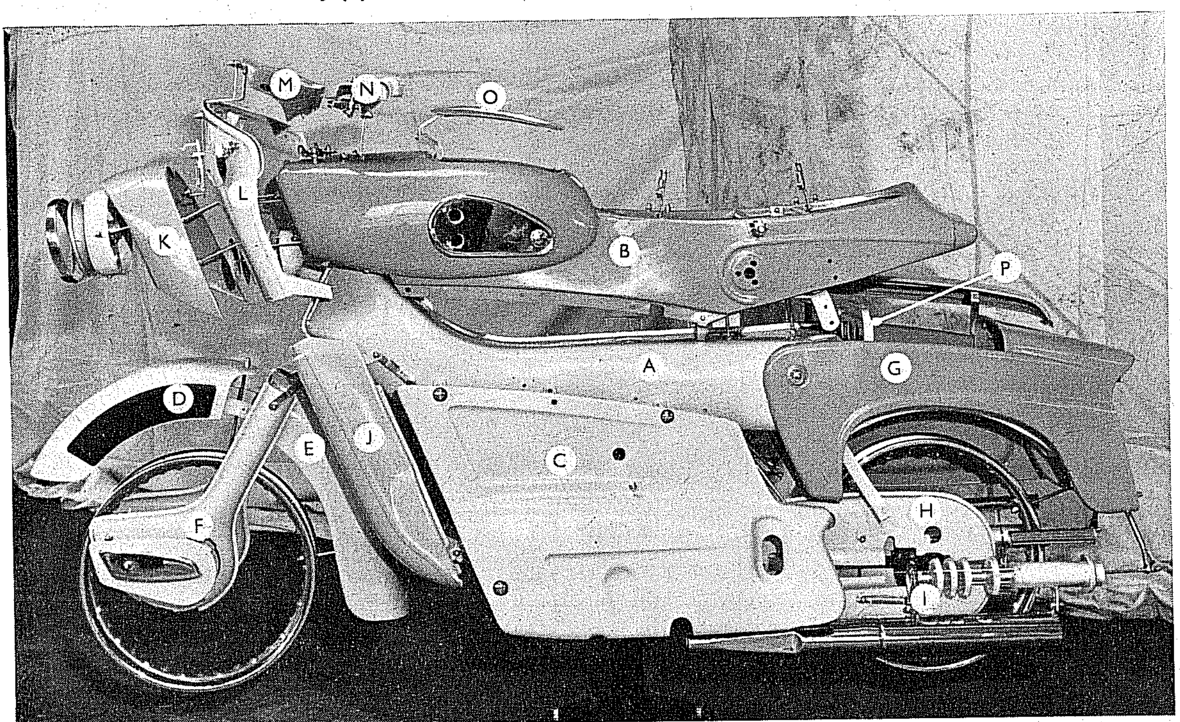
Sheet Metal in ARIEL

A New Concept in Motor Cycle design . . .

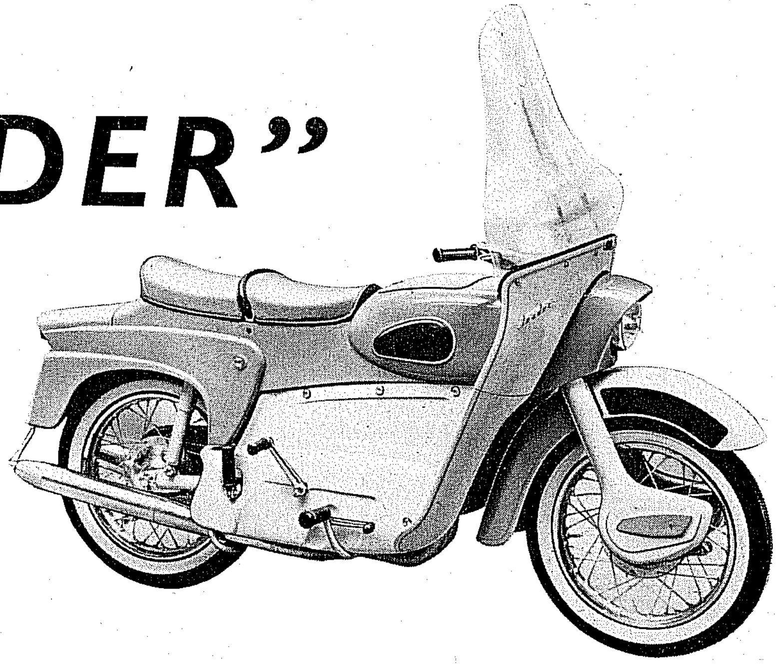
Introduction

WHAT is undoubtedly a most significant step forward in design as far as British motor cycles are concerned was reached in 1958 with the introduction of the Ariel "Leader." Powered by a 249-cc. air-cooled two-stroke engine, the machine is capable of 70 m.p.h., a performance due in great measure to the fact that the main components of the cycle, *i.e.*, the main frame and outer body shell, are of fabricated sheet steel construction (Fig. 1). The machine is almost completely enclosed, but side panels are readily removable to give first-class accessibility to the power unit and transmission. The design of the frame and body is such that there is ample parcel accommodation; the battery and a tool locker are also enclosed within the body; the chain is enclosed in a case composed of two easily removable pressings and the rear end of the body and the rear mudguard hinge upwards to give access to the rear wheel.

Fig. 1.—Some of the component parts of the Ariel "Leader": (A) *Main frame;* (B) *body;* (C) *side panel;* (D) *and* (E) *front mudguard;* (F) *front-fork leg;* (G) *tail cover;* (H) *chain case;* (I) *exhaust/silencer assembly;* (J) *leg shield;* (K) *headlamp cowl;* (L) *front shield;* (M) *instrument panel;* (N) *handlebar cover;* (O) *glove-box lid;* (P) *bulkhead (fitted inside frame at rear of petrol tank)*



the "LEADER"



By L. J. Bacon

The machine also incorporates a cowled headlamp (Fig. 2), a front shield continued downwards on each side into leg shields, an instrument panel, pressed-steel front forks brazed into a malleable iron steering crown, and a pressed-steel cowling for the handlebars.

The main frame comprises, in general, two 20-gauge steel pressings welded together down a centre-line flange to form a rigid box-section structure (Figs. 3 and 5). The frame is upswept at the front to allow the steering column to fit into the steering head at an angle of 65 deg. The frame cross-section is rectangular with radiused corners, and the sides are bowed to resist drumming. The steering-head end of the frame is slightly tapered and at the rear it widens and is forked to form the anchorages of the upper ends of the rear suspension spring units.

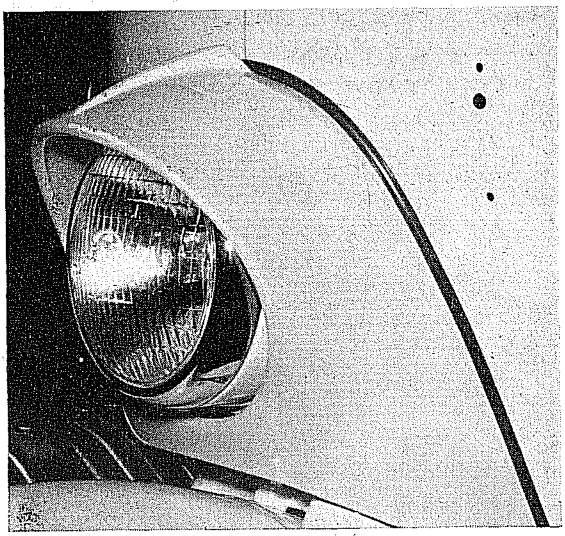
K. J. Whistance, Managing Director, Ariel Motors Ltd.

Fitted inside the frame is a $2\frac{1}{2}$-gal. fuel tank (Fig. 4) composed of two identical 20-gauge pressings welded together. Behind the tank a perforated and ribbed bulkhead is bolted in.

Three box section brackets welded underneath the frame (*see* Fig. 3), also fabricated from 20-gauge sheet, are used to support the engine. The forward two are so positioned that most of the load is taken in shear, and these two brackets are braced by a welded-in channel section bridge piece. The rear bracket, a single unit, incorporates two sleeves, the upper one for the engine attachment bolt and the other for the rear fork spindle. This bracket is also used for an air-silencer chamber, and a stub projecting from the bracket is used for a replaceable air filter.

The rear fork is of welded D-section tube; and below this is a roll-on stand, carried in two engine-unit lugs.

The deep front mudguard is made in two halves with guttered edges, the two halves overlapping at the fork stanchions to which the halves are sealed with rubber beading. To the inner pressing of each fork stanchion is welded a curved channel-section bracket with the flanges facing outward. Welded to the inside of the valances of each mudguard are similarly curved top-hat sections which slide over the brackets. Each mudguard is fastened by two bolts which screw from the inside into captive nuts, and one upward into the fork yoke.



The body shell that encloses the main frame comprises eight main pressings in 20-gauge steel, *viz.*, the upper mid section, tail portion, two side panels, two lower legshields, frontal fairing incorporating the legshield upper ends, and the headlamp cowling. The upper mid section is itself a welded fabrication of five main pressed components. This mid section is bolted to the main frame, and its forward section is shaped rather like a conventional petrol tank that fits over the steering head. On top of this section behind the steering head is a lockable pressed steel hinged cover giving access to the parcel locker.

The hinged dual seat gives access to the rubber-mounted tool kit and battery, etc., and the openin3 on which the seat rests is braced by a transverse tube that houses a pull-out lifting handle. The battery is suspended by a U-shape steel strap.

The body tail section (Fig. 6) is attached to the mid-section by a pivot bolt at each side; the side panels that enclose the power unit are attached to the body by five captive screws with coin slots. The frontal fairing is held to the mid-section by seven bolts, and the upper ends of the legshields fit into channels formed at the base of the fairing. The shields are attached to the main frame at the top and to brackets bolted to the crankcase; these brackets also form the lower front end pick-up points for the side panels.

Fig. 2 (above).—Close-up of headlamp cowl

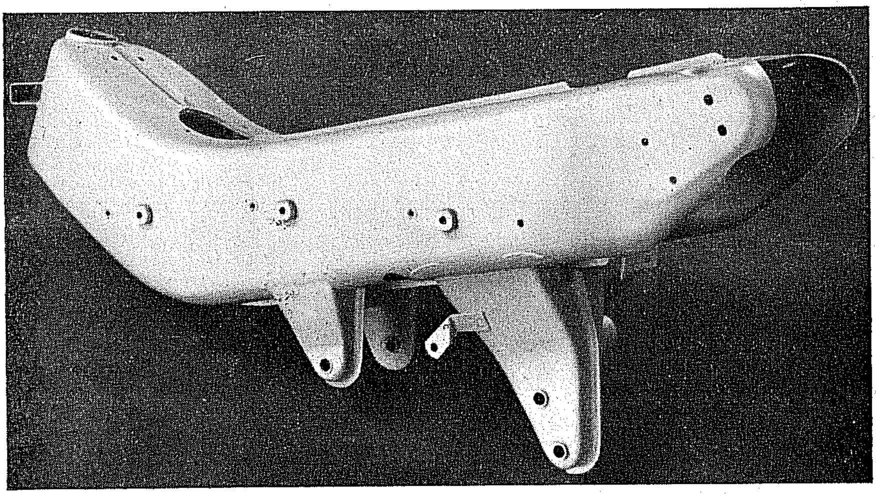


Fig. 3 (right).—Main frame complete with engine-mounting brackets

Other sheet-metal components include the instrument panel and a cowling that fits over the handlebars (*see* Fig. 7). Pressed steel panniers can be supplied if required.

The total weight of the machine is about 300-lb.

The production and assembly of the pressings for the " Leader " is truly a co-operative effort on the part of several firms, including A. J. Homer and Sons Ltd., Fletcher Bros. (Pressings) Ltd., Midland Motor Cycle Mudguard Co. Ltd., and William

Fig. 4 (below).—Petrol tank

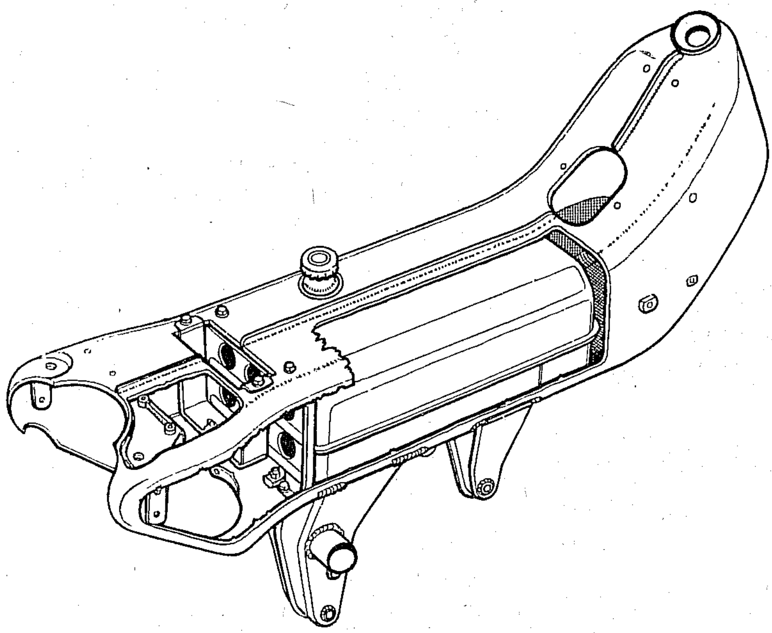


Fig. 5 (left).—General drawing showing construction of main frame cut away to show interior and position of petrol tank

Fig. 6 (below).—Tail-cover assembly

Fig. 7 (below, left).—View of instrument panel and handlebar cover

Pearce (Pressings) Ltd., and for the production of some of the larger pressings a 300-ton Wilkins and Mitchell press was specially installed by A. J. Homer.

As the design of the machine was brought to fruition, it was found possible further to extend the use of sheet metal, for example, for the brake shoes (Fig. 8) and for the clutch unit (Fig. 9), for parts of the front suspension unit, etc. In addition, the silencer assembly is typical of the more conventional use of sheet metal on a motor-cycle (Fig. 1).

Production of Pressings

A. J. Homer and Sons Ltd., Shirley, who are internationally known as manufacturers of motor-cycle and other types of petrol tanks, have a major role in the production of the "Leader." They manufacture the petrol tank, the front forks up to the headstock, the main frame complete, and the bulkheads.

Petrol Tank (Figs. 4 and 10)

Produced from 20-gauge extra-deep-drawing quality steel manufactured by John Summers and Sons Ltd., the petrol tank is pressed in two identical halves on a Taylor and Challen No. 6 double-

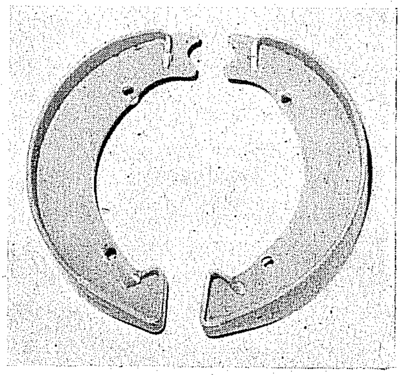
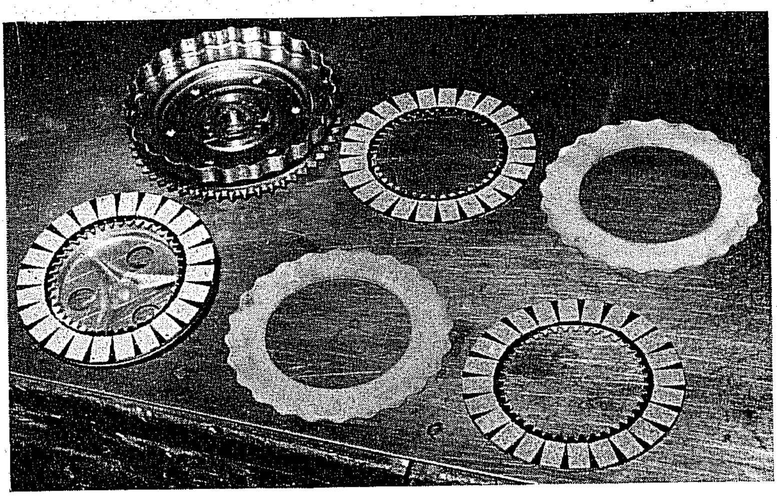


Fig. 8 (right).—Brake shoes



action press, the sequence being—blank, raise and crop, effected as separate operations. After pressing, the two halves are mounted in a jig and spot-welded together round the flange. Spot-welding is only a "tacking" operation, the final weld round the flange being made by a 100-kVA. British Federal seam welder. This machine has an inclined wheel so that during the seam-welding operation the wheel can clear the front tank mounting bracket attached by spot welding to the

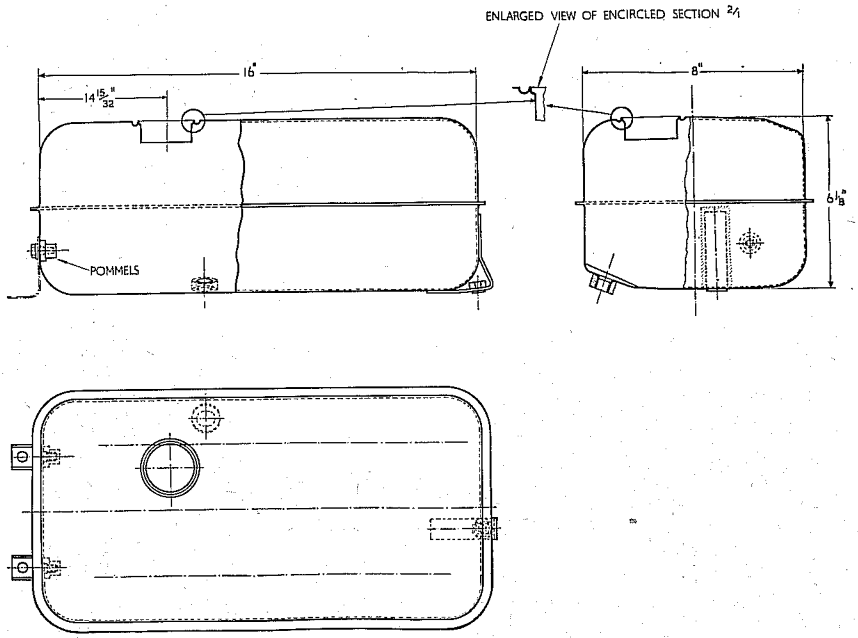
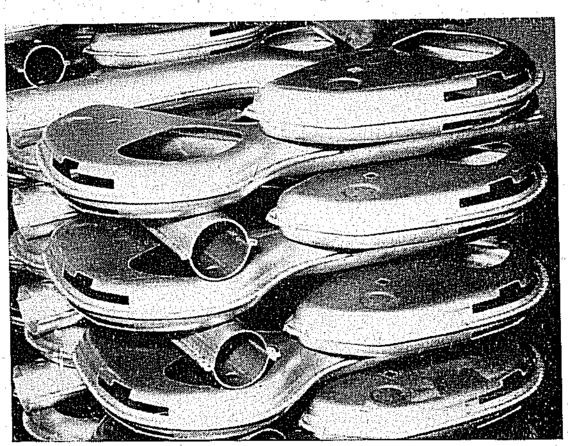


Fig. 9 (*above*).—*Component parts of clutch assembly*

Fig. 10 (*right*).—*Dimensioned drawing of petrol tank (extra-deep-drawing steel* 0.031-*in. thick*)

Fig. 11 (*below*).—*Completed fork legs before brazing to steering crown*



bottom tank pressing before the two halves are tack spot welded. During the pressing operation pierced holes are produced for the filler neck and the petrol tap boss. The filler neck is itself a pressing gas welded into the top of the tank; the petrol tap boss is projection welded (Sciaky 200-kVA. machine) into the bottom of the tank. Also during pressing, holes are pierced to take two threaded bosses, welded to the inside rear end of the tank, to which a right-angled bracket containing four holes is bolted. These brackets form two out of the three mounting points for the tank. A similar boss is incorporated in a simply formed bracket, spot welded to the forward end of the bottom tank pressing; this is the third attachment point for the tank. The completed tanks are

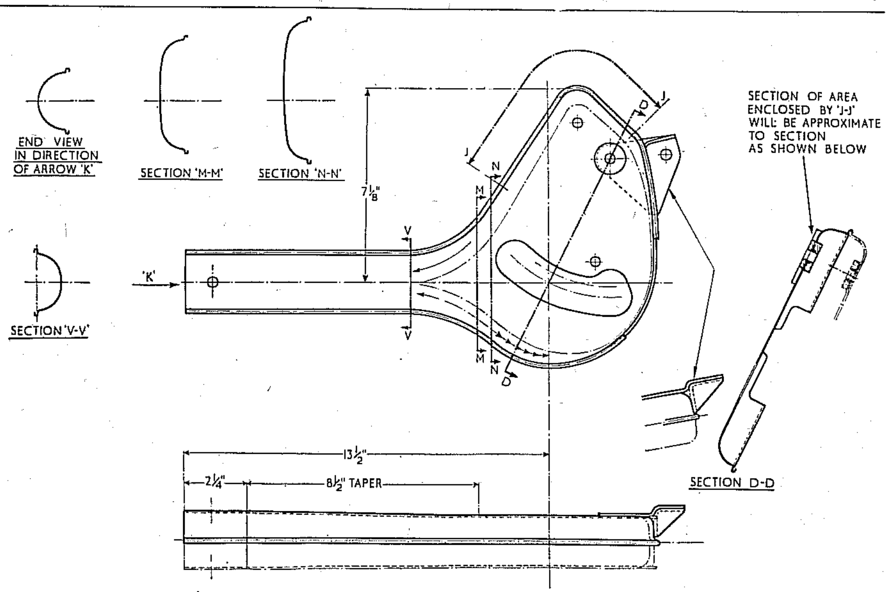
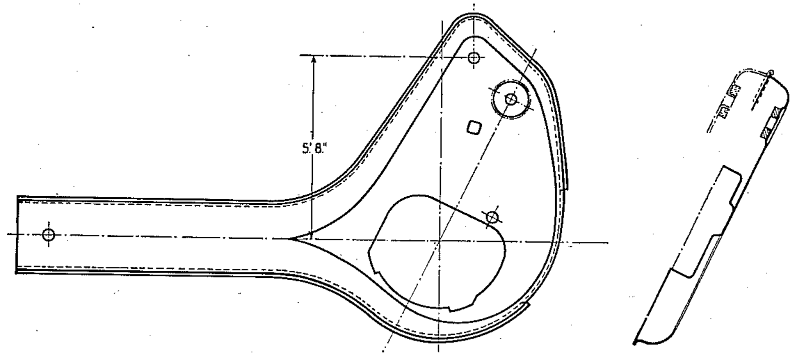


Fig. 12 (*right*).—*Dimensioned drawing of fork-leg inside pressing* (16-*gauge deep-drawing steel*)

Fig. 13 (*below*).—*Dimensioned drawing of fork-leg outside pressing* (16-*gauge deep-drawing steel*)



Bonderized and coated with grey primer. The threaded bosses are all projection welded into the tank by means of a 100-kVA Sciaky machine.

Fork Legs (*Figs*. 11, 12 *and* 13)

The two front fork legs are produced from two identical pairs of pressings, each pair being obtained from a single 16-gauge blank (produced in a 150-ton Rhodes press from Summers' E.D.D. steel) which is cropped and parted as a final operation. The large apertures in the leg components which give access to the suspension units and which are covered on the completed machine by a removable plate, are pierced in a separate operation on a Sweeney and Blocksidge 30-ton power press; the slot in the bottom of the leg is pierced on a hand press. The boss on the inside of each leg pressing, in which the front suspension pivots, is projection welded in place by a Sciaky welder. This boss is machined to size in a subsequent operation at the Ariel works.

One half of each leg has a larger flange than the other (produced during blanking on the Wilkins and Mitchell 300-ton press). The wide flange is turned through 90-deg. and the two halves of each leg are then jigged and spot tack welded together. The flange is then closed over in two operations (Fig. 14) on a Taylor and Challen No. 3½ press; the first operation turns the flange through a further 45 deg., the second giving the final closing.

The large aperture in each leg is for fitting and adjustment of the front suspension unit.

Rear Engine Mounting Bracket

This component is first blanked in the form of the two joined halves of the component, and the required holes are produced in a combination pierce and plunge operation, using a Taylor and Challen No. 4½ double-action press, while the two halves are still in one piece. The two halves are then separated. The air cleaner which is incorporated in the bracket is formed up and gas welded, and then welded into the bracket. The complete bracket is assembled on a jig consisting of two vertical rods which square up the two sets of pressings; the tubes (including the air cleaner) are slipped on the rods between the two pressings and the whole assembly spot welded together and then roller seam welded (*see* Figs. 15 to 17).

The flanged top of the bracket, used to attach the bracket to the frame, is now produced as a separate component which is then forced, in a jig, on to the main bracket assembly and then spot welded. The top portion is drawn, using a Taylor and Challen No. 4½ press, from a shaped blank to save cropping.

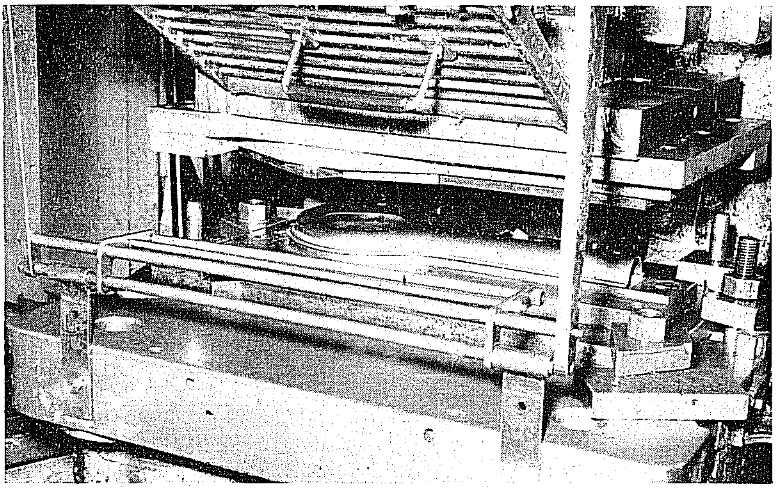


Fig. 14 (*left*).—*Fork leg pressings in press for closing over of flange after spotwelding*

Fig. 15 (*below*).—*Drawing of rear engine-mounting bracket which incorporates the air cleaner* (20-*gauge mild steel*)

Front Engine Mounting Brackets

Again, the two halves of each bracket are blanked in one piece and pressing carried out, after which the whole is cropped and then parted. Holes are combination pierced while the two halves are still joined. A Taylor and Challen No. $4\frac{1}{2}$ press is used. The centre section of this bracket is blanked (Taylor and Challen No. $3\frac{1}{2}$ press) and two boxing operations follow. Holes are pierced singly and plunged using a hand press. The bracket is spot and seam welded up

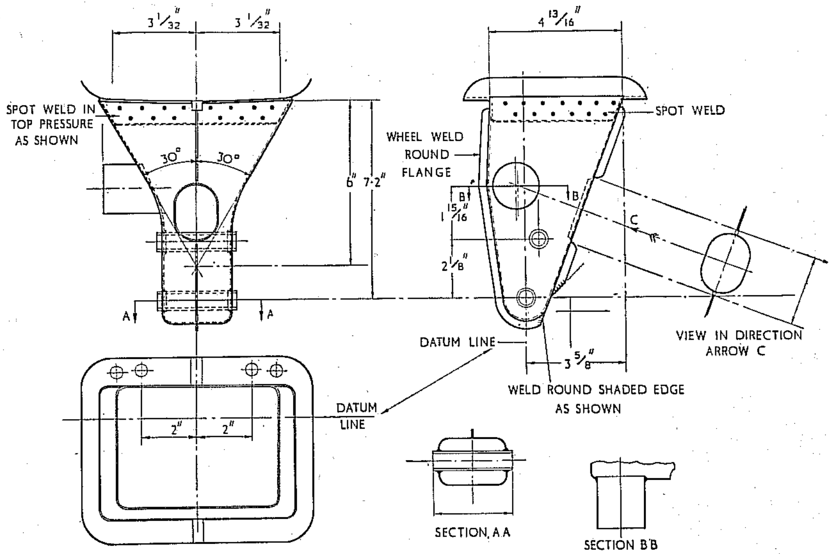
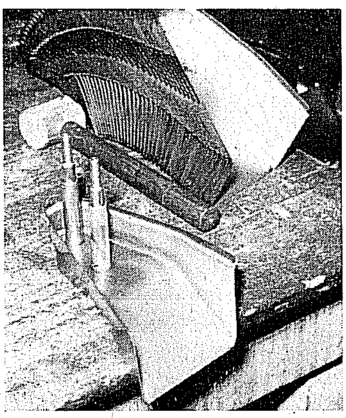


Fig. 16 *and* 16*a*.—*Method of assembling rear engine-mounting bracket*



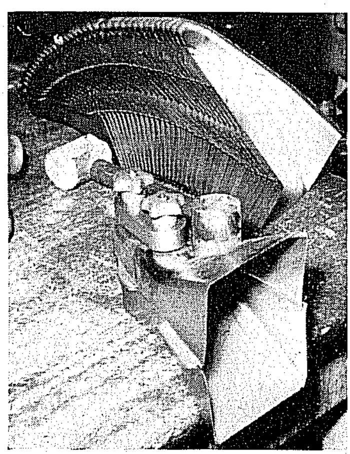
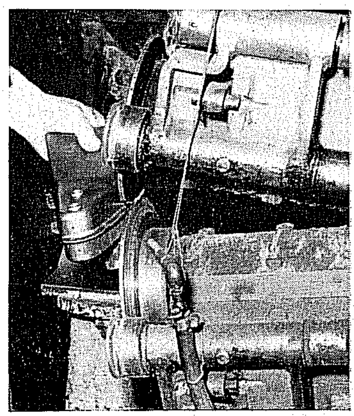


Fig. 17.—*Roller seam welding two halves of rear engine-mounting bracket*



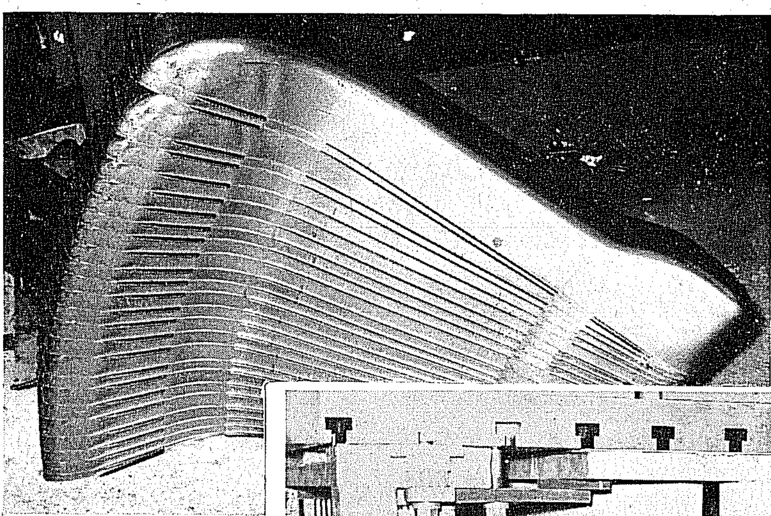


Fig. 18 *(left).—Half pressings of main frame*

Fig. 20 *(below).—Press tools for half pressing of main frame*

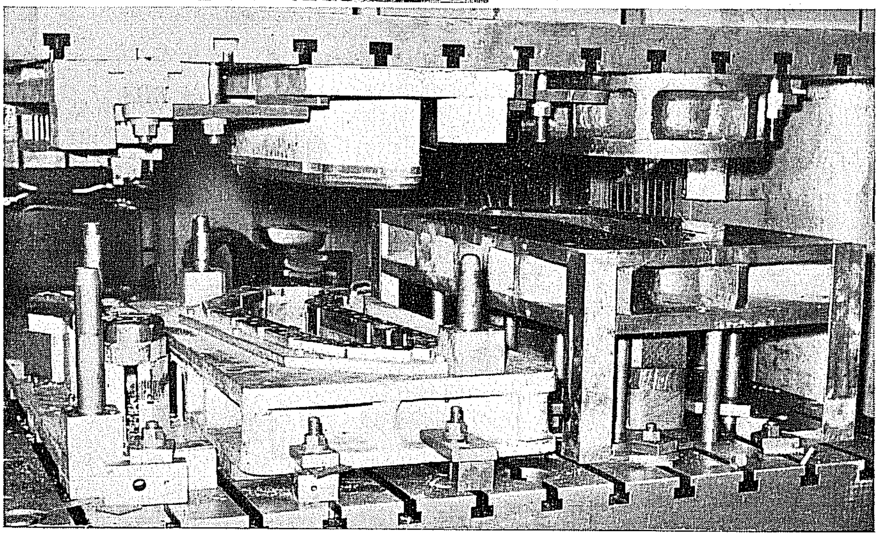
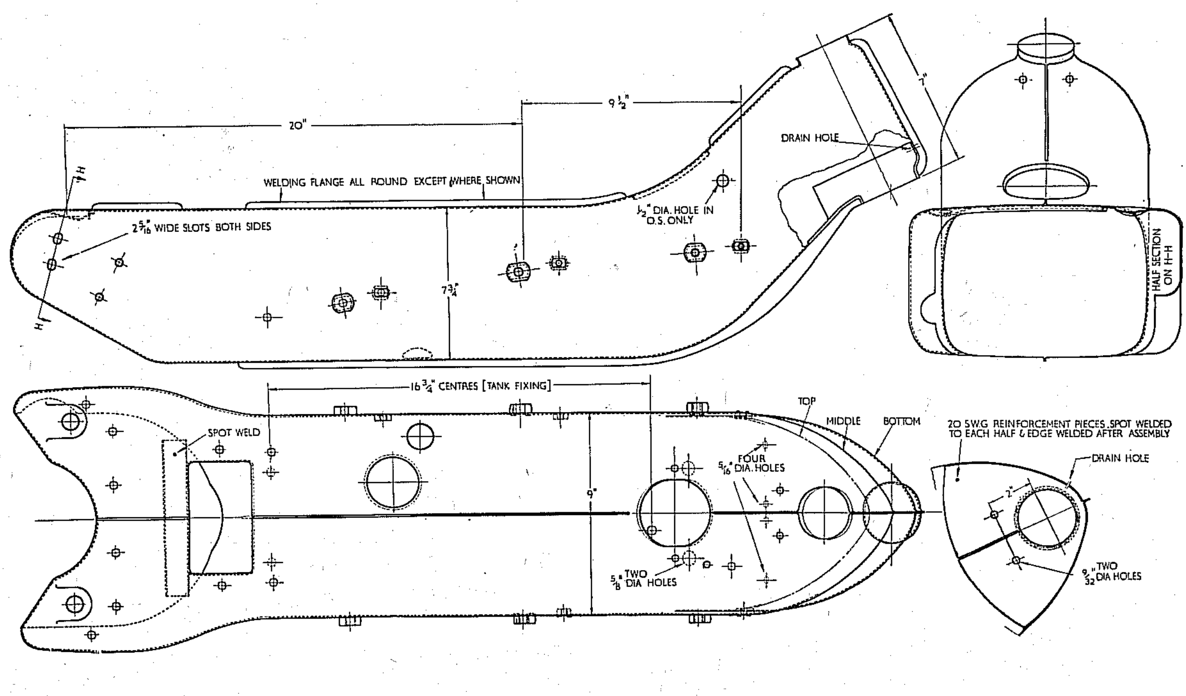


Fig. 19 *(below).—Dimensioned drawing of main frame material 20-s.w.g. steel (deep drawing). The Quasi-Arc Co. Ltd.'s "Vortic" 16-gauge electrodes are used in the fabrication of the frame*



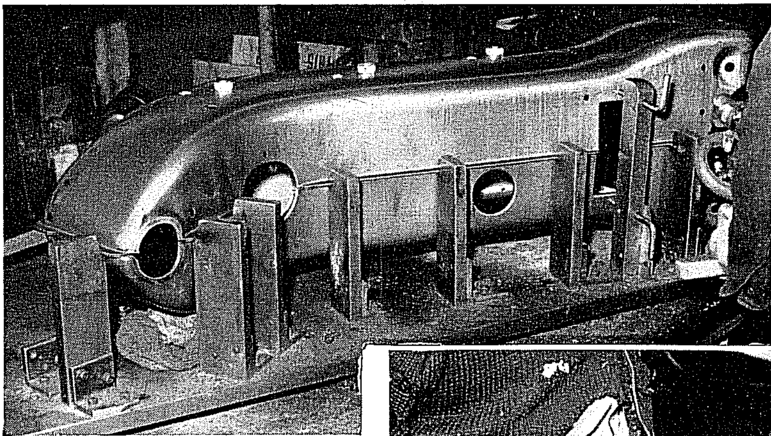


Fig. 21 (*left*).—*Main frame pressings jigged for tack spotwelding together*

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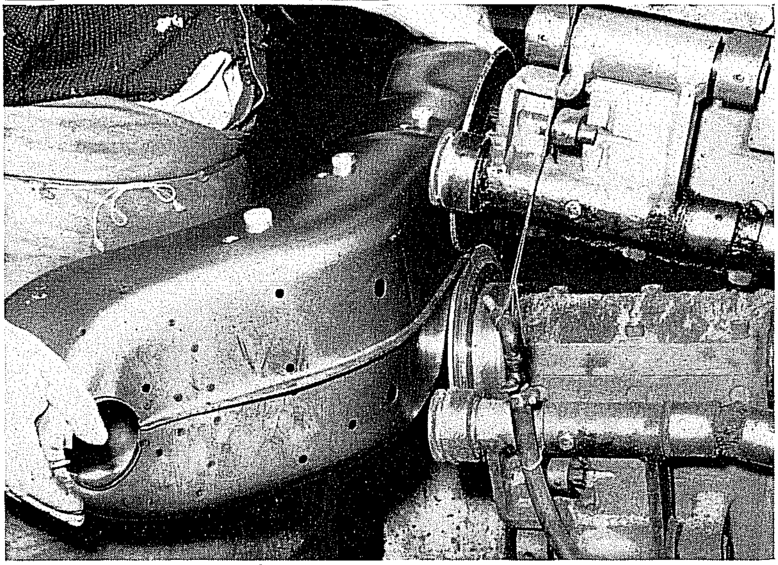
Fig. 22 (*below*).—*Roller seam welding of main frame pressings*



and the tubes forming the two engine mounting holes are gas welded in. These two brackets when attached to the frame are separated by a formed-up channel section piece.

Frame

The two halves of the main frame are massive 20-gauge pressings (Figs. 18 and 19) and necessitated the installation of the 300-ton Wilkins and Mitchell press. Its bed accommodates three sets of tools for raise, crop and com-

Fig. 23.—*Jig for assembling engine-mounting brackets to main frame*

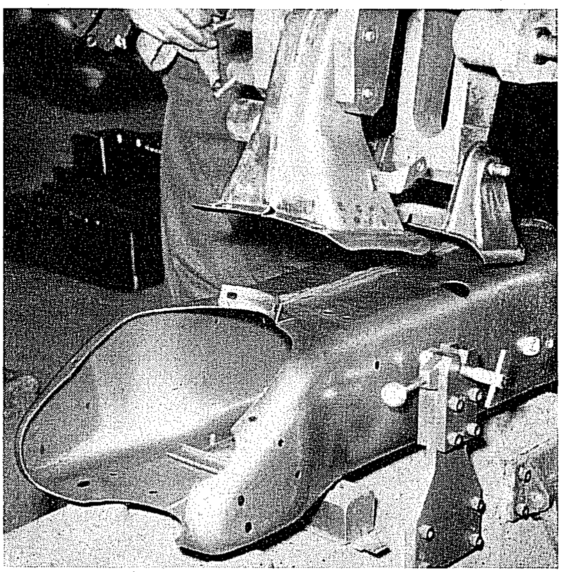
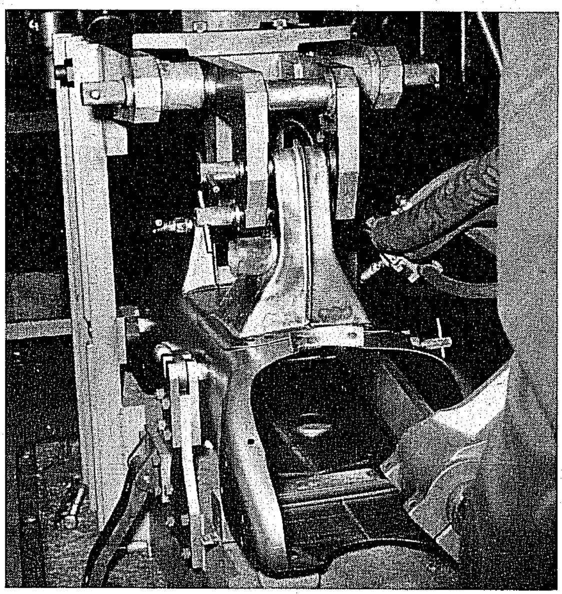


Fig. 24.—*Tack spotwelding engine-mounting brackets to main frame*



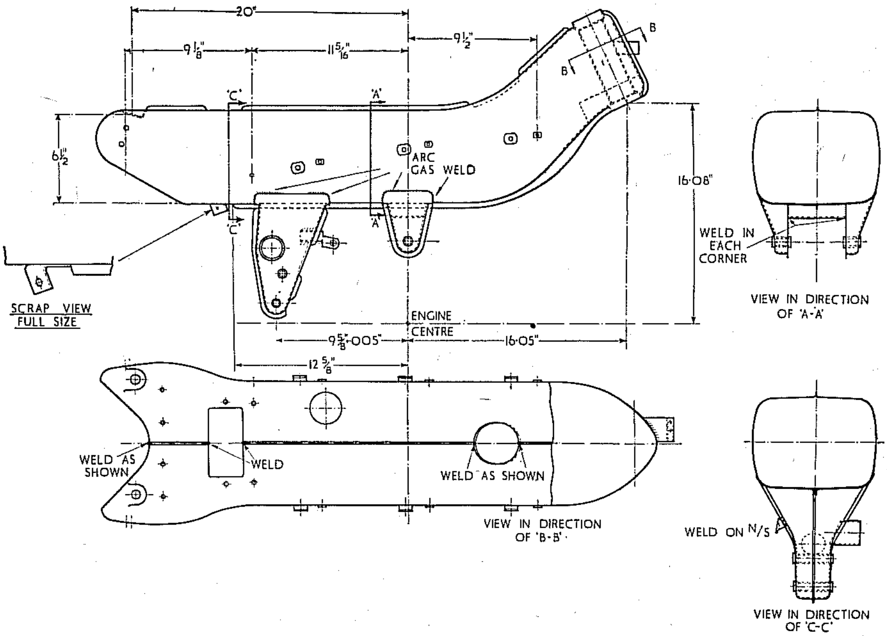


Fig. 25 (right).—Drawing of frame welding assembly

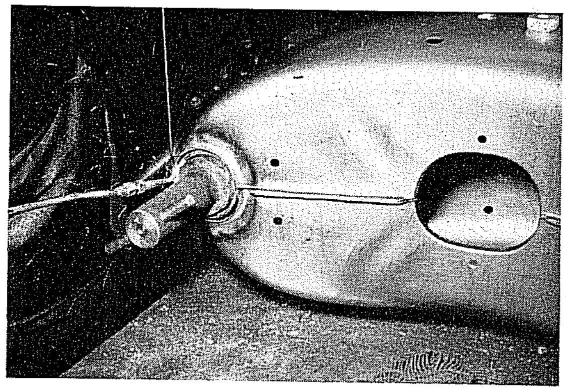
bination pierce operations on previously produced shaped blanks.

Assembly of the frame is by jigging the two halves, spot tack welding round the flange (Fig. 21), and finally joining by roller spotwelding (Fig. 22). A reinforcing piece is welded into the front end to stiffen up the steering head. The rear stiffeners are then added and also the mudguard bracket. The assembly is then jigged using the body attachment holes, and the engine mounting brackets are placed in the jig using the mounting holes as a location (Fig. 23). The front and rear engine mounting brackets are then spotted on to the frame (Fig. 24). The frame welding assembly diagram is shown in Fig. 25.

The assembly is then jigged again, and location this time is by the engine mountings. At this stage the steering head tube is welded into the frame (Fig. 26) and the horn mounting bracket gas welded to the front of the frame.

The steering head assembly consists of a gas-welded 16-gauge sheet-metal formed tube, on to the top and bottom of which a recessed pressing is gas welded. These pressings take the machined cups which form part of the steering head ball races. The head assembly is inserted from the bottom of the frame and when in position is gas welded to the top and bottom of the frame without using filler rod. Enough metal is allowed on the flange round the holes in the frame to allow for this. Thus the top side of the frame involves the welding of two thicknesses of metal, the frame itself and the pressing on the head assembly, while at the bottom three thicknesses are involved

Fig. 26 (below.)—Gas welding steering head tube into main frame



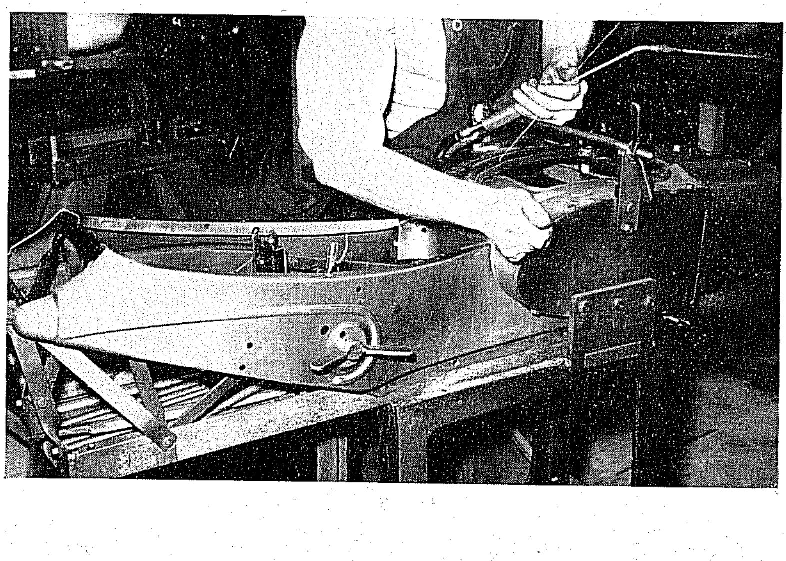


Fig. 27 (right).—Gas-welding operations on jigged body pressings

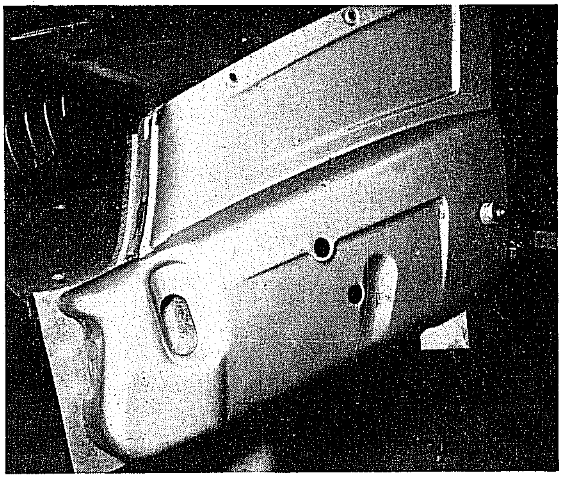


Fig. 28 (above).—Side panel set up for planishing

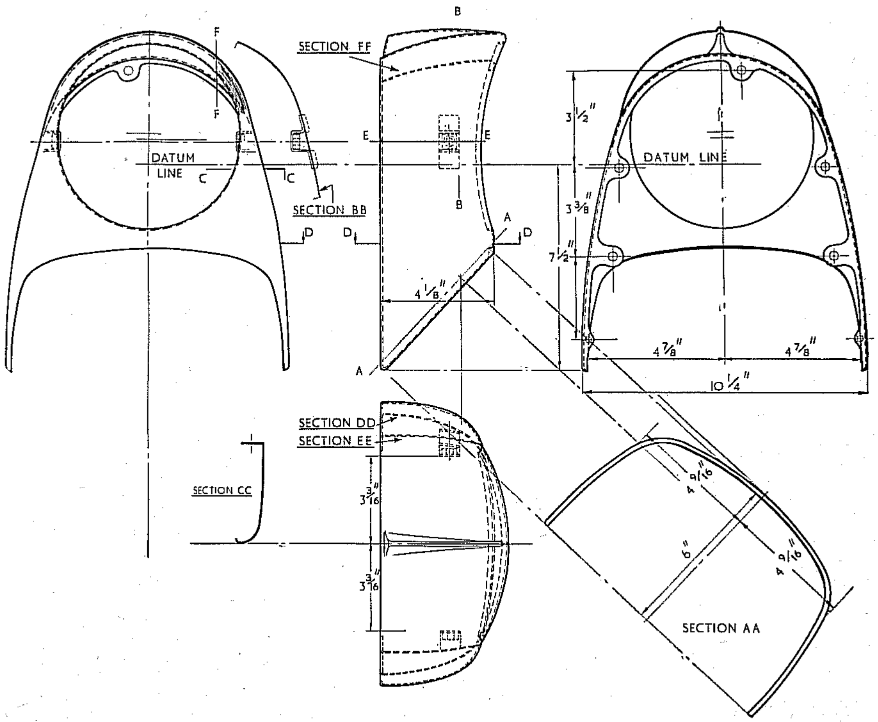


Fig. 29 (right).—Drawing of headlamp cowl (22-gauge deep-drawing steel)

due to the stiffening plate welded into the frame, as previously described.

The body of the machine which is assembled by A. J. Homer consists of eight main components assembled in jigs (Fig. 27) at first by gas and spot tack welding. Final welding is by spot welding at the Ariel works. These body pressings are produced by Fletcher Bros. (Pressings) Ltd., Holyhead Road, Handsworth, Birmingham 21, who also produce other pressings for the " Leader " motor-cycle. This company is a member of the Concentric Group of Companies, and has been producing high-quality pressings for the motor and allied trades for many years.

The components produced for Ariel Motors Ltd., comprise :—

(i) Body side panels ;
(ii) Headlamp cowls ;
(iii) Front shields ;
(iv) Legshields.

Body Side Panels (Right and Left Hand)

These panels (Fig. 28)—formed from 22-gauge material—provided a problem in the early stages. No double-action presses were available, and a Wilkins and Mitchell press No. 844, equipped with air cushions, was eventually used for the job. Although the dies were fitted with draw-beads, a great deal of experimenting with blank sizes, material specifications, cushion pressers, etc. had to be carried out before the panels could be successfully formed to full depth in one operation.

All the usual troubles, *i.e.*, cracking, puckering, crowding of metal into corners, etc., were successively met with and overcome, and the best results are now being obtained by using stabilized material.

The gauge thickness is closely controlled, and R. D. Nicol's " Droyt " drawing compound is used.

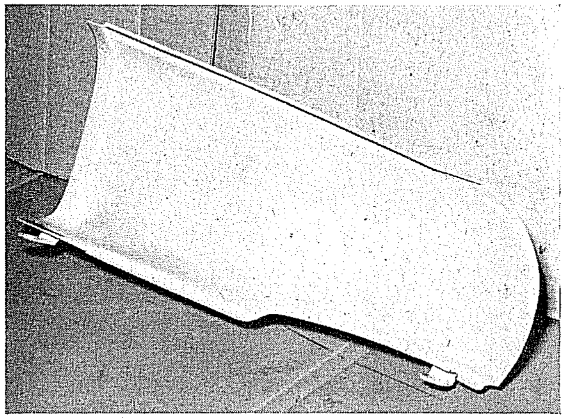
It is also interesting to note that a small piece of coarse emery paper placed on the blank was the answer to the problem of metal being drawn from several directions and converging at a point which made crowding of the material almost inevitable, and—although considerable experimenting was carried out with draw-beads—the use of emery paper provided the complete answer.

Subsequent operations included the piercing of the majority of the numerous holes in one operation, and clipping operations to get rid of the surplus material and finalise the shape of the pressings.

All the tools were produced in the firm's own tool room, and because of the fairly modest output required, easily maintained tools were provided.

Headlamp Cowl (*Figs.* 2 *and* 29)

The headlamp cowl is also an interesting pressing, and initially the chief difficulty was to provide a good and presentable finish to the top



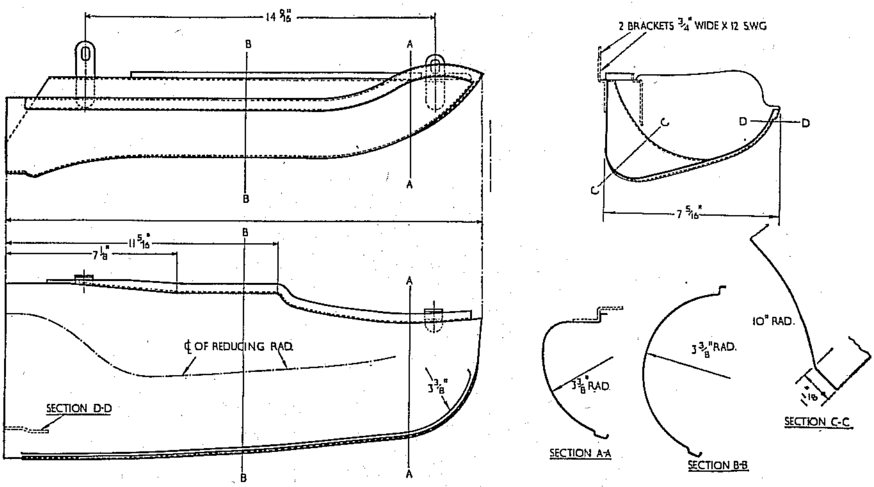
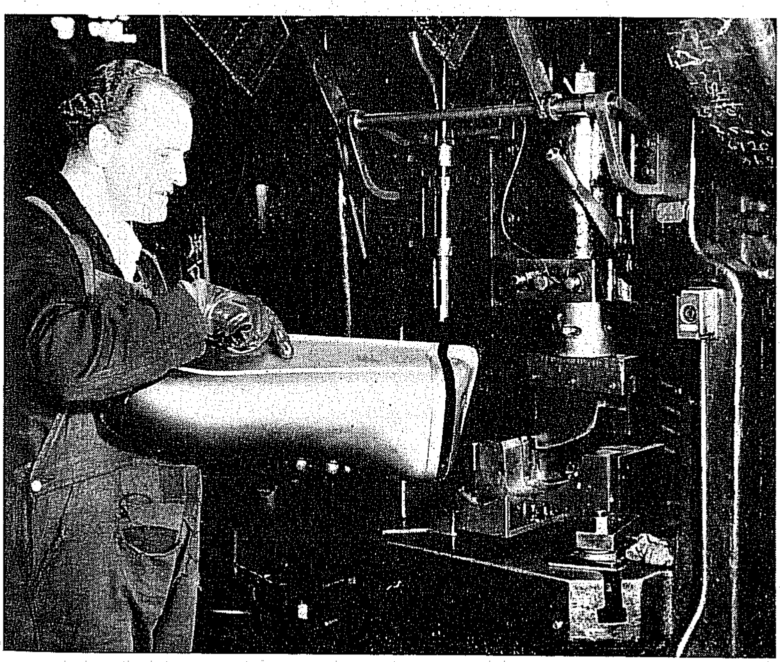


Fig. 30 (*above*).—*Interior view of leg shield*

Fig. 31 (*left*).—*Dimensioned drawing of leg shield* (22-*gauge deep-drawing steel*)

Fig. 32 (*below*).—*Clipping operation on sides of leg shield* (*Sweeney and Blocksidge No.* 38 *press*)



of the cowl, *i.e.*, the portion which the rider would see when seated in the saddle.

As originally designed, the rib was not included, and it can readily be imagined that the combination of the two large radii—running at right angles to each other—resulted in puckering and crowding of the metal.

The method originally used was to notch out a V-shaped piece of metal and close the edges together to provide the contour called for by the drawing, but as welding and pressing operations were involved, the method proved very costly.

In consultation with Ariel Motors Ltd., it was decided that pushing up the surplus metal to form a rib would not

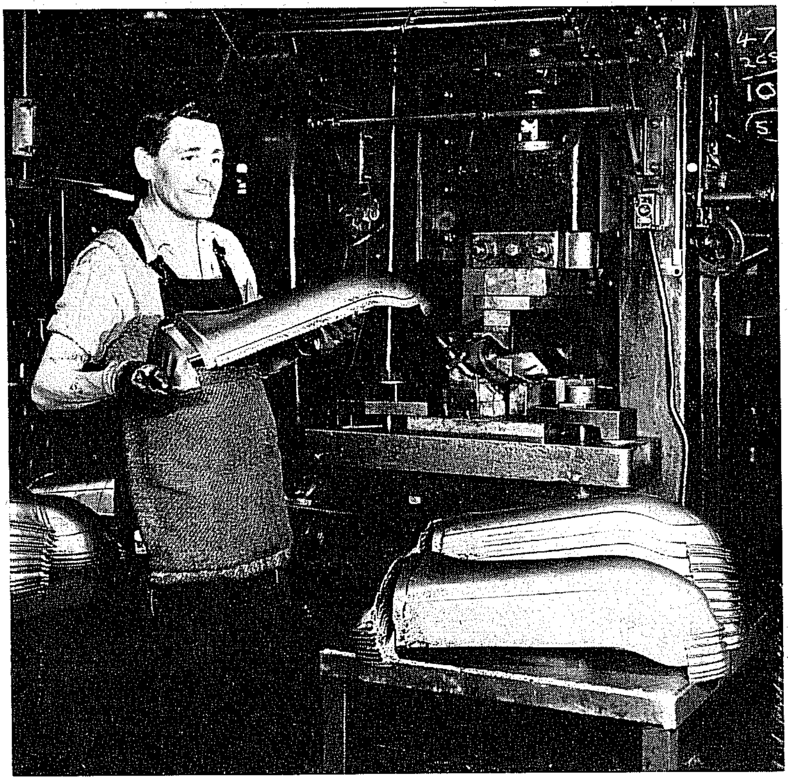


Fig. 33 (left).—Clipping operation on bottom of leg shield

Fig. 34 (below).—Dimensioned drawing of handlebar cover (20-gauge deep-drawing steel)

only improve production, but also result in a more streamlined and pleasing appearance.

Front Shields and Legshields (Figs. 30 to 33)

The front and leg shields presented no undue difficulties to produce, although it was found necessary to use stabilized material, and pay particular attention to gauge thickness to ensure that the pressings were free from " kinks " and surface blemishes.

Another firm invited into the team chosen to produce components for the "Leader" was William Pearce (Pressings) Ltd., 44, Ormond Street, Birmingham, 19.

A firm of wide repute in the car and motor-cycle manufacturing industries, about 120 staff are employed, and in the 25 years the company has been in existence, a considerable amount of experience and " know-how " of the complexities of metal forming have been built up.

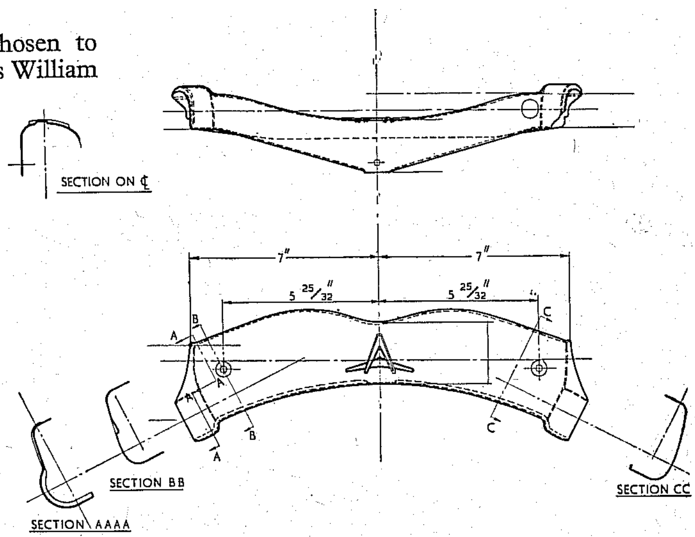
Pearce's undertook to provide 47 components for the machine, and to produce these, approximately 450 sets of tools have been designed and manufactured by the company itself. To meet the time schedule initially drawn up for production samples, the company's tool room developed the tools within nine months, and not one of the samples subsequently submitted was rejected by Ariel Motors Ltd.

The main components being made by Pearce include the instrument panel, handlebar cover, and clutch housing (*see* Figs. 7, 9 and 34). When the original cast brakeshoes were later replaced by others fabricated from heavy-gauge sheet steel, these also were made by the company (Fig. 8).

The company are currently building a new factory in the Brownhills area of Birmingham for presswork and final assembly, and the main press shop is to occupy 7,000 sq. ft. Office and store accommodation, laid out on modern lines, will complete what will be an attractive and efficient plant.

Instrument Panel

The material used for this component is 22-gauge deep-drawing-quality mild-steel sheet with full



finish. The component was too large to be formed on the firm's existing double-action presses, and a Taylor and Challen Model 1664 100-ton open-fronted press was used. Despite this apparent fitting of a " quart into a pint pot," a satisfactory component was produced.

Brief details of the Taylor and Challen 1664 press are as follows :—An open-fronted geared press, the bed and slide are of large area, and both have machined T-slots. The slide is spring balanced, and ample tool space, combined with rigidity of frame, make the press useful for a variety of comparatively heavy press operations. A patent automatic key clutch and one-stroke trip gear are fitted as standard. The machine will cut out a blank in mild steel 19 in. dia. by $\frac{3}{32}$ in. Extra equipment obtainable includes top and/or bottom extractors, spring or pneumatically-operated die cushion (for use with combination tools), and an adjustable stroke giving a range of $\frac{1}{2}$-in. to 4-in. or $1\frac{1}{2}$-in. to 5-in.

The stroke maximum is 7-in. (usual 4-in.) with a usual rate of strokes per min. of 35. Bed area, right to left, is 44-in., and front to back 26-in.

Made from a sheared blank, the panel was first raised and embossed on its top section, then clipped and redrawn. Side cropping and piercing tools were employed for follow-up operations, so that hand work has been virtually eliminated in production.

After tooling had started, the panel section was deepened by a considerable amount, and it was at this stage that it was discovered that the component was too big for the double-action press initially scheduled for the job. The tools were adapted to the Taylor and Challen press with successful results.

Handlebar Cover (*Figs. 7 and* 34)

Produced from the same gauge and quality sheet as the instrument panel, a developed blank was used for the handlebar cover to eliminate a number of cropping tools that would otherwise have been required.

Most of the larger raising tools used in manufacture were produced from nickel-chrome castings, cast to close size control, and the company says that this enabled considerable economies in tool costs over conventional methods.

The difficulties experienced in making the cover were caused by crowding of the metal into the centre section, and skidding during the raising operation, particularly since no tooling holes were available for use as locating points.

Crowding was overcome by incorporating a raised letter " A " as an embellishment on the top face of the cover. A developed blank was reverted to when it was found that a balancing effect created by increasing the blank on the short side led to the crowding reaching impossible dimensions. With a developed blank the embossed " A " was sufficient to overcome this difficulty. Semi-combination type tools were used for the raising of the panel.

Skidding commonly experienced with this type of raising varies considerably, of course, when a discrepancy in the nominal gauge of the metal is encountered, a variation of 0.003-in. being sufficient to make the job impossible.

A pre-bending operation introduced before the raising procedure largely overcame this problem.

The sequence of operations finally adopted for making the cover was, therefore: forming from a developed blank, pre-bent, raising, forming and piercing the back, and turning in the ends to fit in the twistgrip groove of the handlebar.

Clutch Housing

The clutch housing (Fig. 9) is a two-dimensional diameter shell of 16-gauge sheet steel. The open

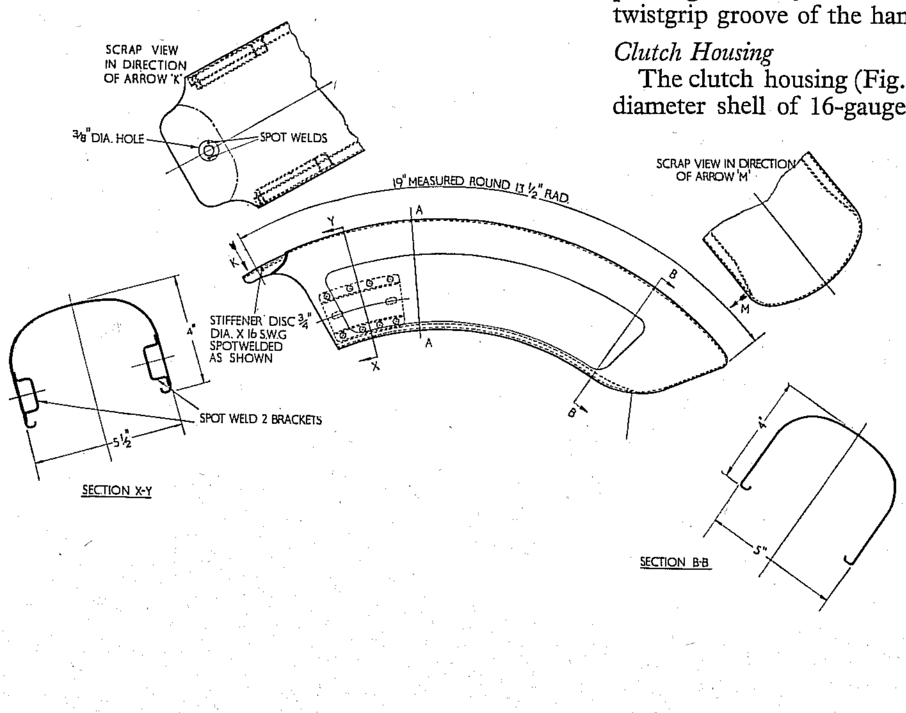


Fig. 35.—Dimensioned drawing of front mudguard leading section. (E.N.2A, 22-gauge)

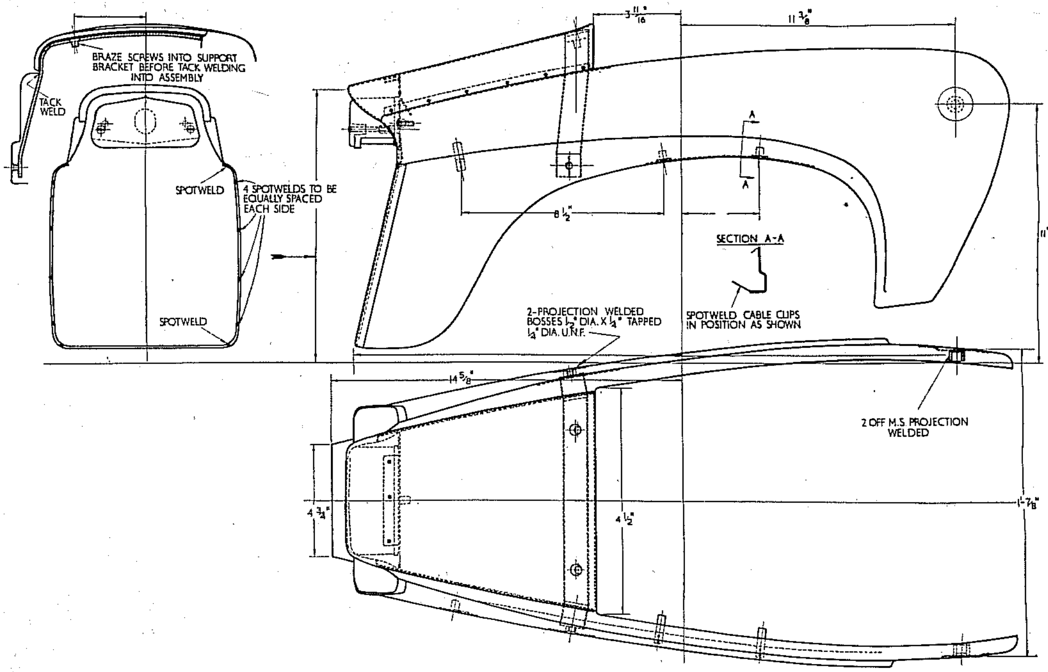


Fig. 36.—*Dimensioned drawing of tail cover assembly*

end of the large diameter is scalloped around the periphery to match corresponding tongues in the clutch plates.

Using a formed blank, the raising operation is made with semi-combination tools, and the housing is subsequently blocked to impart the critical squareness and flatness required for the plate bearing area.

* * *

Another firm making components for the "Leader" is Midland Motor Cycle Mudguards Ltd., Sandy Lane, Birmingham 10, founded only six years ago as an associated company of Bacol Manufacturing Co. Ltd., a firm specializing in the manufacture of press tools and presswork.

In this comparatively short time the company has expanded rapidly, and additional premises have recently been acquired to contend with increasing demands.

The company is adept at devising tools for the more unorthodox type of presswork. Prototype examples of intricate forms that have recently been made by them include a front mudguard of modern design that incorporates a deep sectioned body fairing, and a cowling that provides not only a shroud for the top section of a telescopic fork, but also a housing for a headlamp unit.

Three major components for the "Leader" being made at the company's works are the front mudguard, the rear chaincase, and the tail cover assembly.

Front Mudguard (*Fig.* 35)

This comprises two pieces—a front and a rear—formed from high grade 22-gauge steel.

Many operations are involved in the manufacture of these guards, from an initial rolling to form a straight section carried out in one operation on a rolling machine; this utilizes six sets of precision rolls driven by a 25-h.p. motor through a reduction gear. After train rolling the section is passed through a curving machine, comprising top and bottom precision rolls and a slipper or former that can be mechanically adjusted to give the required radius. Any radius can be obtained by adjustment of the slipper. The drive to the machine is from a $7\frac{1}{2}$-h.p. electric motor through a chain.

All-special purpose equipment and precision rolls for these operations were made by Midland Motor Cycle Mudguards.

Tail Cover Assembly (*Figs.* 6 *and* 36)

The tail cover assembly is fabricated from four pressings, all of 22-gauge d.d.q. mild steel, comprising a left- and a right-hand side panel, a top cover, and a number plate. The four components are spot welded together, and a raised strap in 10-gauge steel is brazed between the side panels and top cover to provide a rear anchorage for the component on the motor cycle.

Used in the production of these parts are a Hordern, Mason and Edwards 200-ton double-sided double-crank press, two open-fronted presses, a Taylor and Challen 100-ton and a Bliss 75-ton, and No. 5 fly presses.

In the pressing of the panels, buttons inserted in the punch ensure that the flow of metal around the compound curvature at the rear of the panel is smooth and free from wrinkling.

After the initial forming of the top cover, the workpiece is mounted on a mandrel in a No. 5 fly press. An interesting tool developed by the company is that used to impart the final forming of the turned over flange. It comprises two mechanically operated side-action dies that clamp the workpiece to the mandrel before the vertical force is applied, ensuring that the correct form of the piece is maintained.

Joining of the parts begins with the brazing operation, when stud bolts are welded to the 10-gauge strap, the strap is brazed to the top cover, and threaded bosses are brazed into position in each of the holes in the side panels.

After this, a jig is used for the spot welding operations, when the number plate is joined to the side panels, and the top cover is joined to both side panels and the number plate. The jig aligns with the pivot holes in the side plates and the weld-studs on the brazed-in strap.

Welding machines used for these operations are a Holden and Hunt 15-kVA. and a British Federal 8-kVA. resistance welding machines. Brazing is with "Sifbronze" No. 1 spelter rod, supplied by the Suffolk Iron Foundry.

Rear Chaincase (*Figs.* 1 *and* 45)

The component is designed as an enclosure for the rear driving chain, and is not intended to be oiltight. Although the finished case consists of a top and bottom half, it is made in two pieces as an inside and an outside. Each piece is subsequently divided along a longitudinal centre line, the two bottom halves being then joined, and the two top halves joined, by a standing seam, spot welded around the periphery.

The main operations in its fabrication comprise blanking and forming on 200-ton double-sided double-crank presses. Included in the raising are raised portions to clear the swinging arm and rear plunger, and a joggled strip that is subsequently cut through to form a stepped joint.

Following operations comprising: (1) piercing eight apertures in the front section and six in the rear; (2) turning the flange on the front section through 90 deg.; (3) dividing longitudinally; (4) completing the standing seam to make the upper and lower sections; this is done by first bending the flange through a further 45 deg. on a seaming machine, and then making the final turnover by using a punch and die conforming to the profile of the case halves in 75-ton open-fronted presses; and (5) five spot weld spaces around the periphery of each section to complete the joining operation.

The finished chaincase can be assembled to the motor-cycle without the need for any further work in fitting.

Throughout all drawing operations at the company's works, the lubricant used is Edgar Vaughan and Co.'s "Hough to Draw."

Final Assembly

At the Ariel works, Selly Oak, Birmingham, most of the operations effected are virtually those of final assembly as regards the sheet-metal components on the motor-cycle, although many of the mechanical components for the engine are manufactured there.

In the main frame of the motor-cycle the petrol tank is fitted on rubber mountings by three-point suspension and thus provision is made for this on the bottom part of the tank. The rear of this portion has two threaded bosses welded to the inside of the tank, locating on two holes pierced in the tank wall. On to these two bosses a right-

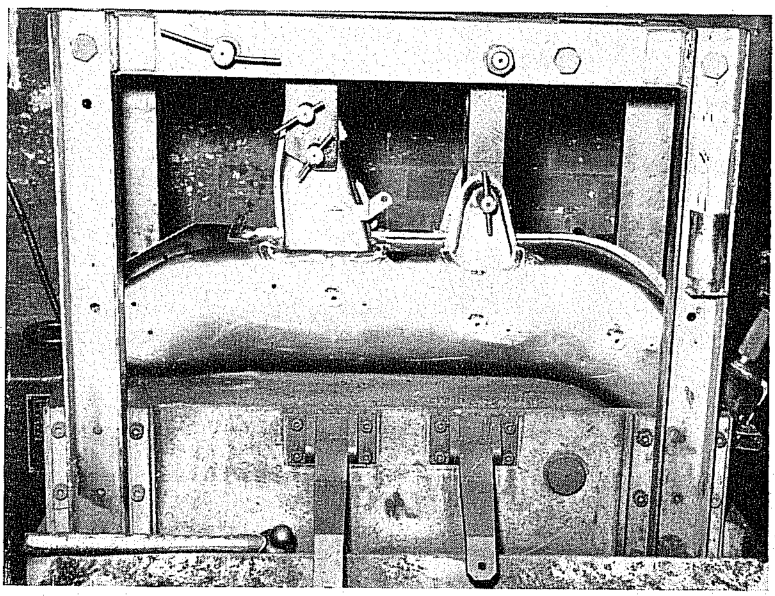
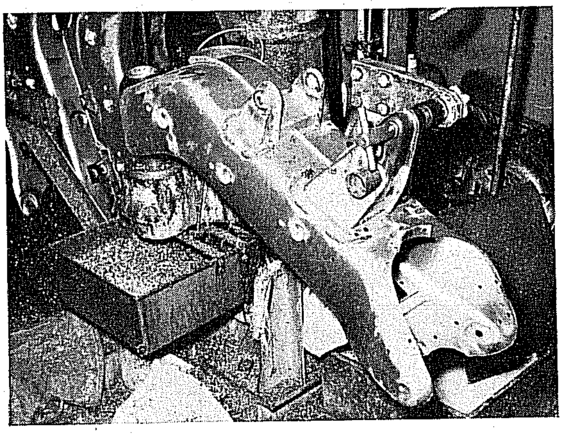


Fig. 37.—*Frame assembly jigged for final welding of engine-mounting brackets, mudguard support bracket and six panel nuts*



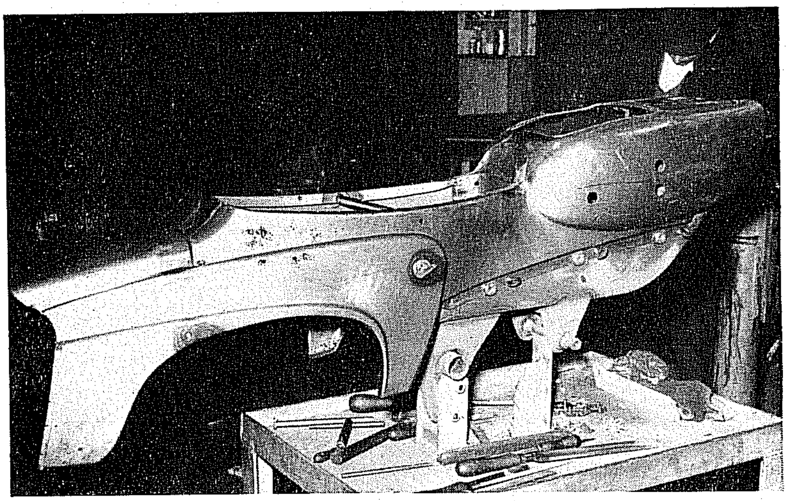
The main frame, also consisting of two halves seam welded together, undergoes several operations before it is ready for use on the motor-cycle. As received, the frame is complete with the rear engine mounting bracket which also incorporates the air silencer, and the front engine mounting bracket. In addition, the lower part of the upswept front portion of the frame has been stiffened internally by the welding in of an extra thickness of metal.

At Selly Oak the frame is first jigged to ensure that the various holes, of which there are about 50, are accurately positioned. The frame is then jigged upside down and the front and rear engine mounting brackets are arc welded (16-gauge rod) (in addition to the spot welds previously made) to the frame for additional strength (Fig. 37). In this jig the rear mudguard support bracket and six threaded bosses on to which the body is attached are also arc welded into position in previously pierced holes.

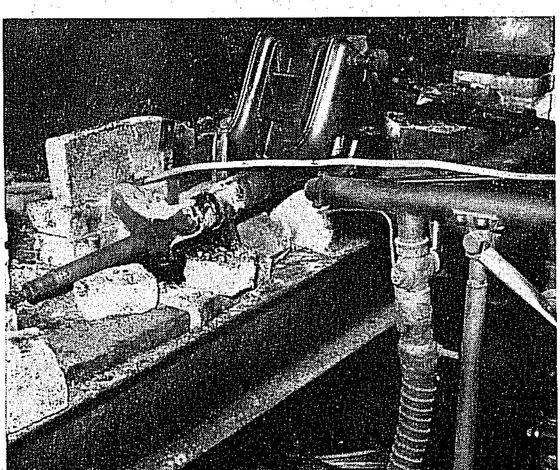
Fig. 38 (above).—Machining steering head recess to take bearing cups. Location is from engine mounting bracket

Fig. 39 (right).—Tail-cover assembly fitted to body

Fig. 40 (below).—Brazing steering crown to fork legs



angled bracket containing four holes is bolted. A similar boss is provided for the third mounting portion, but this is incorporated in a simple formed bracket spotwelded to the forward end of the bottom tank pressing.



The next operation is to machine the steering head recesses that take the bearing cups (Fig. 38). To do this the frame is first jigged upside down, locating in the holes in the engine mounting brackets, and then the whole assembly is turned upside down, rejigged, and the other end machined. These two operations are effected on a drilling machine on to which the jigs are attached.

Following this the rear damper-unit mounting, the steering head angle and the engine mounting bracket centres are again gauged and set. Various brackets, such as the horn mounting bracket, are also spot welded on, after which the whole frame is cleaned, Bonderized and coated with grey primer.

The body shell is set on a master frame assembly and final spotwelding carried out, and then the tail end assembly fitted (Fig. 39). This complete assembly is then cleaned, Bonderized and sprayed with grey primer.

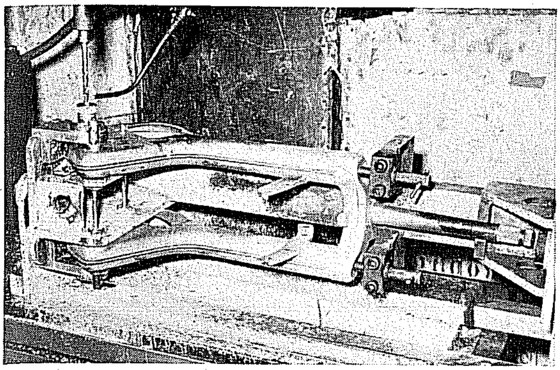


Fig 41 (*above*).—*Drilling projection-welded bosses on fork-legs*

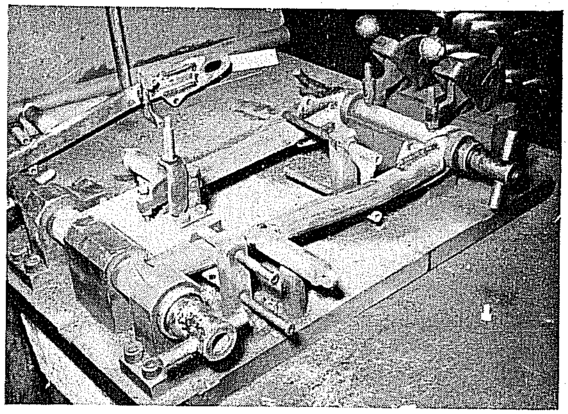


Fig. 42 (*above*).—*Rear-fork components jigged for welding*

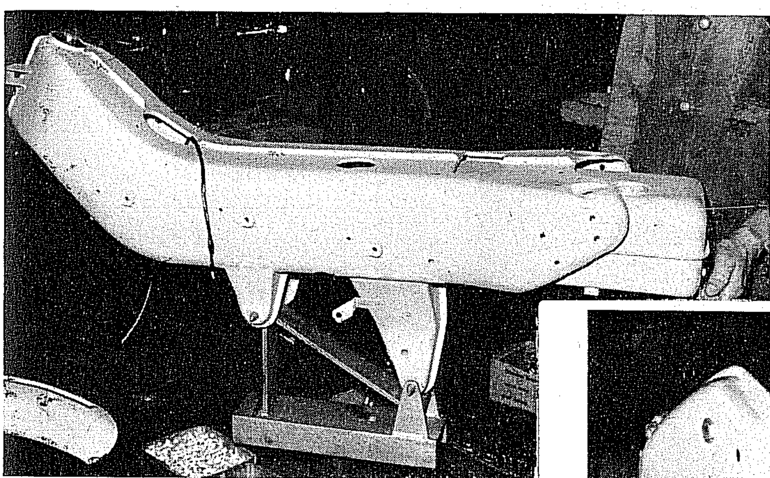
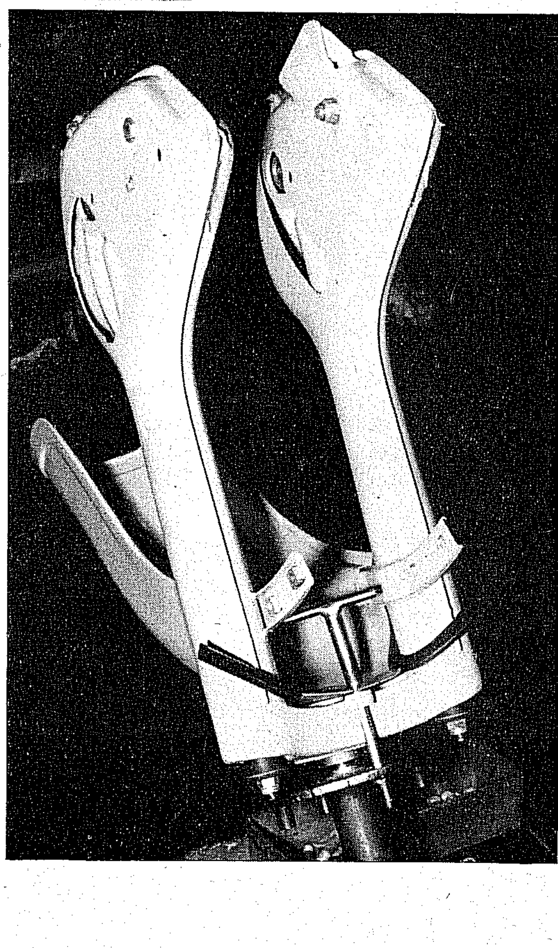


Fig. 43 (*above*).—*Assembling petrol tank into main frame*

Fig. 44 (*below*).—*Front forks with front suspension assembled and half of front mudguard*



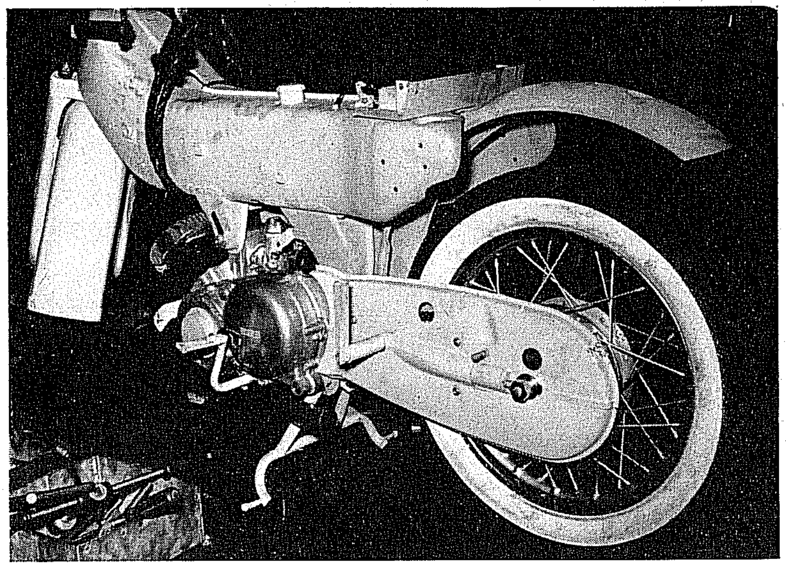
Side panels are also set on a master pattern and planished where necessary (Fig. 28).

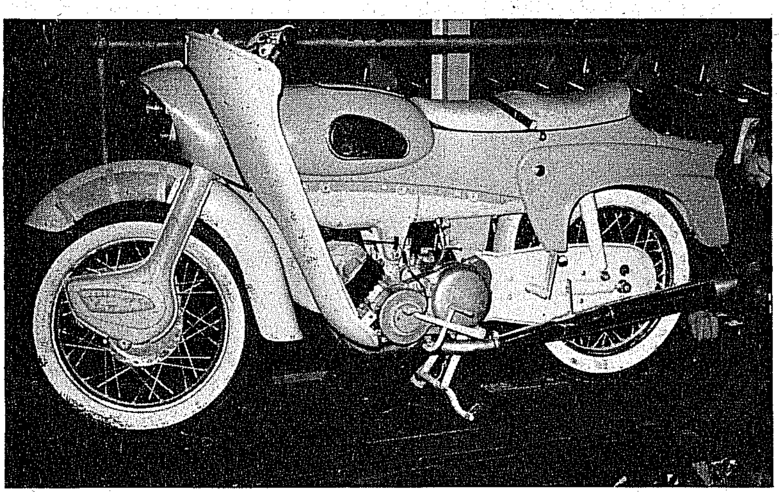
The legs of the front fork assembly arrive at Selly Oak assembled. After checking each leg assembly and removing any surplus metal a pair of legs is brazed on to the malleable cast-iron crown, on to which the steering column is also brazed (Fig. 40). The U-section brackets to which the front and rear parts of the front mudguard are attached, are arc welded to the front fork assembly, one bracket to each leg. The two bosses, projection welded to the lower end of each leg and in which the front suspension pivots, are drilled in a turnover type jig attached to a vertical drilling machine (Fig. 41). The front fork assembly is then Bonderized and painted with primer, after which the front suspension is assembled (Fig. 44).

The two halves of the front mudguard have top-hat sections spot welded inside into which the brackets on the fork legs locate. The mudguards are Bonderized, primed and sprayed with colour. Mudguards are attached to the front fork legs by captive nuts.

Fig. 45 (right).—Early stage in final assembly sequence (prior to track). The chain case pressings are shown assembled

Fig. 46 (below).—A "Leader" nearing the end of the assembly line





Rear Fork

This is a welded fabrication made from D-section tube. The component parts of the assembly are jigged and arc welded (Fig. 42).

Assembly Sequence

First the electrics, ignition coil, etc., are assembled into the main frame. The fuel tank is fed into the frame from the rear (Fig. 43) and mounted on its three rubber pads. The rear bulkhead is bolted in so that if necessary at any time the fuel tank can be removed. The bulkhead stiffens up the rear end of the frame in conjunction with the rear end bracket which is also bolted in. This, bracket, in 9-gauge mild steel, fits under the rear of the frame. A U-section stiffener is spot welded in at the rear of the opening left for the battery, then a further bracket to which the rear mudguard is attached is spot welded on to the underside of the frame.

The battery carrier is dropped into the aperture provided and bolted in; the tool tray is also dropped on and two body brackets underneath the mudguard are fitted in the bottom of two centre holes provided. The frame then goes to the final assembly track after the front forks (together with suspension) and steering column and the rear mudguard have been fitted.

The engine is put on a jig table at the beginning of the track and the frame dropped on to it (Fig. 45);

(*Continued in page* 62)

Painting

All components are Bonderized and primed as early as possible, and some components, *e.g.*, the chassis frame and fuel tank, are left in this condition.

The primer paint is of the zinc-chromate type and components are transported after spraying on a Teleflex conveyor through a Parkinson-Cowan infra-red oven in which the stoving temperature is 600° F. for 9 min.

Finish coats are in synthetic paint; they are stoved in a Carrier Engineering camel-back gas-fired convector oven for $1\frac{1}{2}$ hours at 240° F. All finish coats are polished after stoving with car polish.

Spraying is effected in water-wash spray booths of Bullows and Aeraspray manufacture; these firms also supplied the spray guns used.

Local Buckling of Aluminium Plate Elements

(*Continued from page* 61)

Another and more serious trouble was that the standards in calculation and workmanship were so much more exacting in aeronautical engineering than in structural engineering that these standards must be relaxed to obtain competitive solutions. In structural engineering what this meant was best shown in an example:

The cost of ordinary aluminium structures in Switzerland was as follows:—

	Fr/kg.
Material (on weight of main parts only) approx. cost .. .. .. =	5.–
Labour (including cost of minor parts) approx. cost .. .. .. =	10.–
	15.–

The first comment on these figures was that labour costs more than material; in order to obtain competitive structures, therefore, the labour cost must be kept down and it was necessary not to worry too much about material cost or extreme lightness of the structure. This excluded in structures all the weight-saving "tricks" obtained through a complication of the design and the ensuing increase of labour cost. What was acceptable were weight savings due to more exact calculation but which were not coupled with a refinement of the structure which was not common in structural engineering.

Only on very rare occasions had the author heard of structures built in accordance with the principles of aeronautical engineering; all such structures cost a multiple of the figure quoted above.

In transport engineering it was more usual to encounter structures built in accordance with the principles of aeronautical engineering. He remembered a case where self-supported folding sheet-steel bus bodies were built in this way. But also here the costs were 30 per cent higher than similar bus bodies designed along conventional lines and the weight only slightly less, so that the savings in operation paid off the increased first cost only after several years.

In summarizing the situation, he could say that the aeronautical engineer must forget a great deal of his experience until he could turn out competitive designs in the fields of structural and transport engineering.

As regards rounded-off corners of sheet-metal sections, the structural designer liked them sharp because they left more clearance for riveting and fastenings. He had, therefore, assumed in the investigation sharp corners, which gave the greatest width of the plate elements and hence represented the most unfavourable conditions. The k′ values are calculated for this condition.

He had found that when a designer obtained too low a critical stress he was inclined to interpose curved parts between the plate elements, thus reducing the width of the plate elements and consequently obtaining a higher critical stress in local buckling. Such edges, however, were not as stiff as sharp edges and the calculated gain in critical stress was not achieved in practice. In order to stop such a fallacious procedure he insisted that the width of any plate element be calculated from the fictitious point of intersection of the middle lines of the adjacent plate elements (*see* paragraph 2.1.3).

The Ariel "Leader"

(*Continued from page* 22)

the rear end is assembled including the pivoted fork, rear wheel, chain drive, chain case, etc.

The wiring harness is then connected up and the anti-theft lock and front wheel added. The next stage is to assemble the body shell, handlebars, glove box lid and the tail portion. The sequence is then: dual seat; silencer; lifting handle; instrument panel; front shield; handlebar cover; headlamp and cowl; complete wiring, and finally the legshields and removable side panels.

Acknowledgements

Grateful acknowledgment is made to K. J. Whistance (Ariel Motors Ltd), J. A. Bott (A. J. Homer Ltd.), J. A. Walker (Fletcher Bros. (Pressings) Ltd.), G. T. Pierce and S. A. Wharton (William Pierce (Pressings) Ltd.), and E. C. Barber and L. G. Green (Midland Motor Cycle Mudguards Ltd.) for their co-operation in the preparation of this article.

Institute of Sheet Metal Engineering

(*Continued from page* 69)

Conference should be on an international scale and offers of papers have already been made from overseas countries as well as from the U.K.

Further invitations have been and are being sent out to known experts in this field and offers of papers or suggestions in connexion with the Conference will be welcomed by the organizing sub-committee and should be addressed to the Hon. Secretary, ISME, John Adam House, Adelphi, London, W.C.2.