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 turn-over 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-

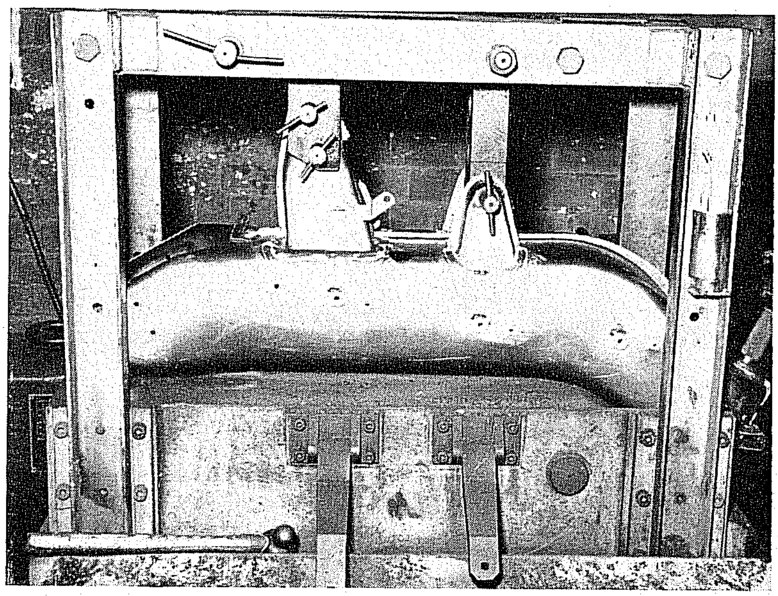
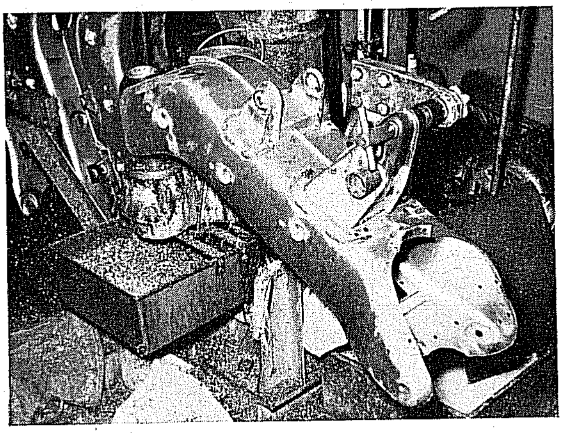


Fig. 37.—Frame assembly jigged for final welding of engine-mounting brackets, mudguard support bracket and six panel nuts



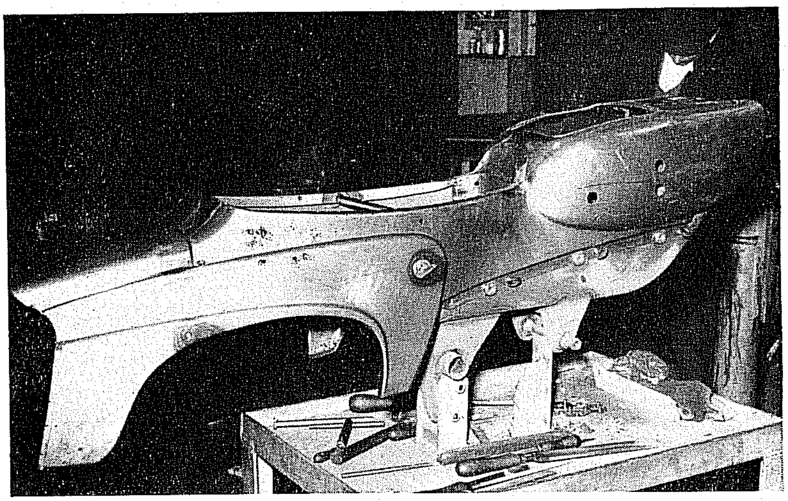
The main frame, also consisting of two halves seam welded together, undergoes several operations before it is ready for use on the motor-cycle. As received, the frame is complete with the rear engine mounting bracket which also incorporates the air silencer, and the front engine mounting bracket. In 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.

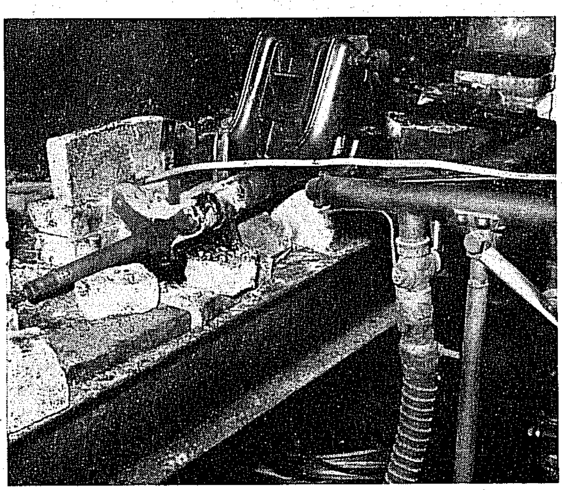
Fig. 38 (above).—Machining steering head recess to take bearing cups. Location is from engine mounting bracket

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.

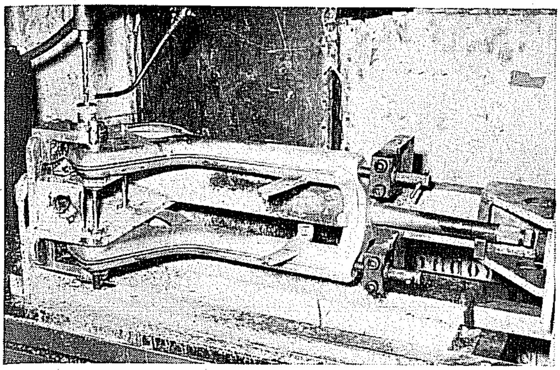
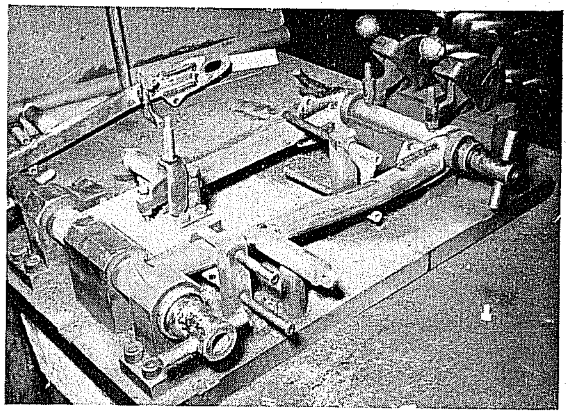


Fig 41 (above).—Drilling projection-welded bosses on fork-legs



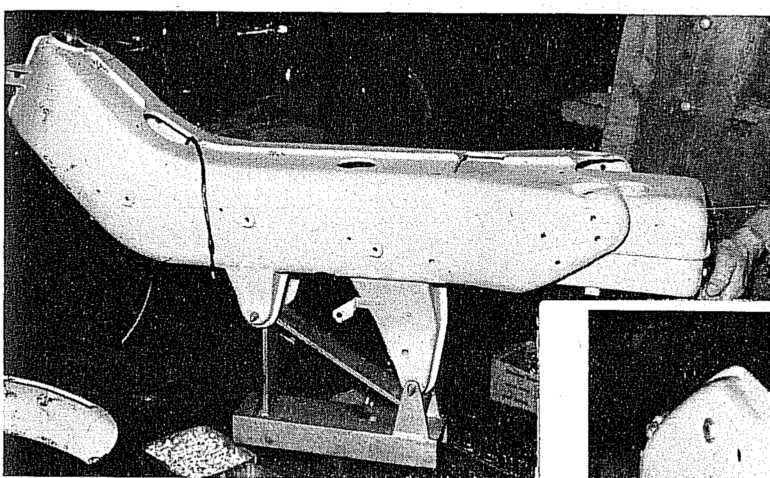
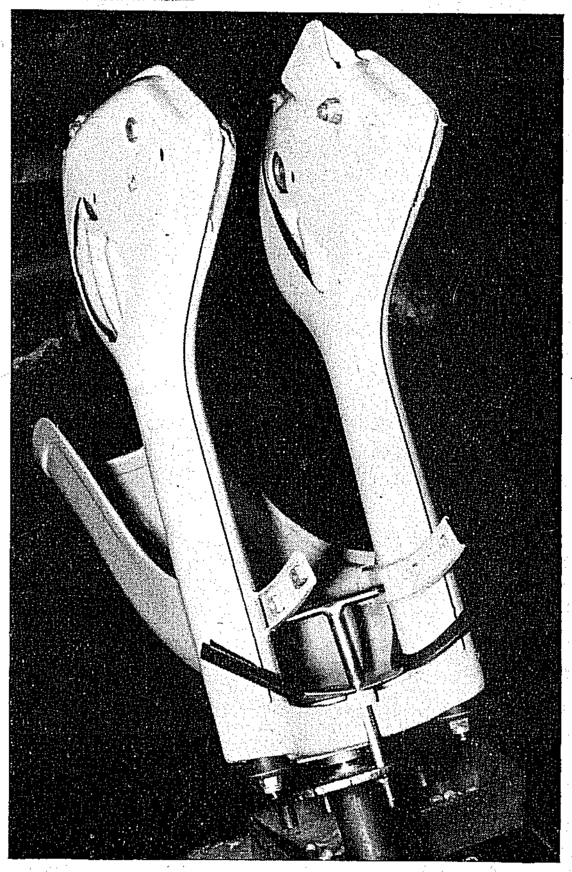


Fig. 43 (above).—Assembling petrol tank into main frame

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

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.

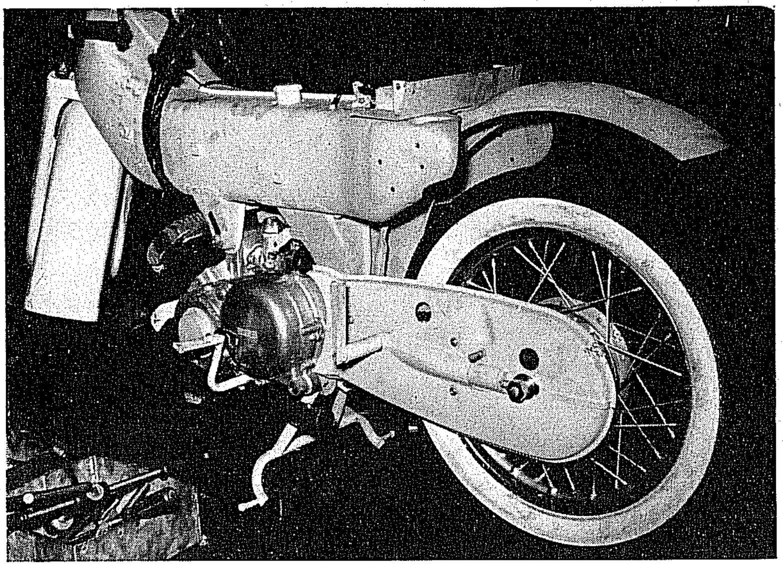
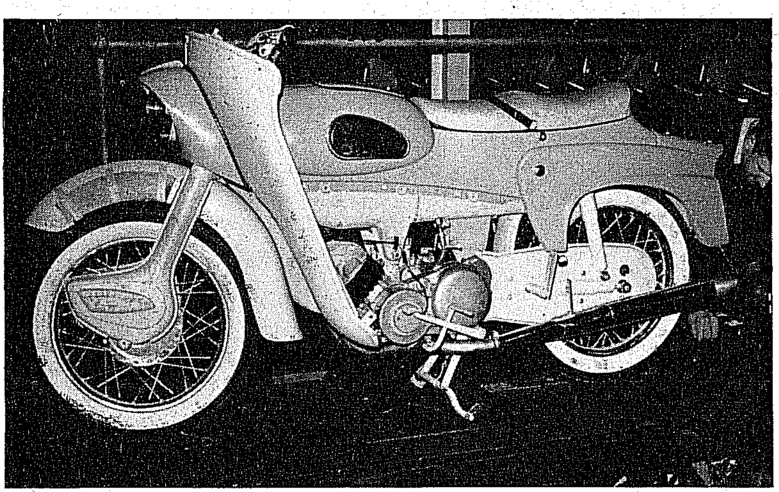


Fig. 45 (right).—Early stage in final assembly sequence (prior to track). The chain case pressings are shown assembled

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

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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.