MOTORCYCLE ENGINEERING—14

PRESSWORK

by PHIL IRVING

PRESSED steel is used in many applications not directly concerned with the frame. Items which spring to the mind are petrol and oil tanks, toolboxes, battery containers and chaincases which, with the exception of the first-named, can be made rapidly and cheaply from light-gauge, deep-drawing quality sheet steel on small presses using relatively inexpensive tools.

Petrol tanks present their own problems. They are frequently made from a top section and two side-panels welded together in order to get some desired shape, and subsequently welded to a bottom section which usually incorporates the tunnel required to clear the top tube. Components of this nature are not subjected to frame stresses and, in fact, should be insulated by rubber mountings from them and from induced stresses due to relative movement of the attachment points, or engine vibration.

The petrol tank, especially the saddle pattern, can become the victim of vibration or frame distortion quite easily, because it is weakened very markedly in a transverse direction by the tunnel and may contain an amount of fuel equal to three times its own weight. Under the action of vertical vibration, the tank tends to hinge about the top line of the tunnel. If the natural frequency of this "tuning-fork" type of vibration coincides with a regularly used spot in the engine speed range, the tank will sooner or later split at one end of the tunnel unless the end areas are locally reinforced or steps are taken to prevent such vibration.

One method is to mount the front end of the tank in frame-brackets with two rubber-bushed bolts, spaced several inches apart, screwed into the tank-floor. This will hold the sides together, but the rear mounting must then be narrow or else quite flexible in order to avoid twisting loads being applied to the tank. Care must also be taken to stiffen the tank-floor adequately in the region of the front bolts, otherwise fatigue-cracks will occur due to the metal deflecting locally.

To provide a wide bracket is not convenient with some frame designs, and it may be much simpler to weld two ears to the tank tunnel-sides and bolt these to the head-lug. In this case it may be necessary to tie the halves of the tank together by a bolt and distance-piece, or some similar device, to prevent destructive vibration.

One of the outstanding features of the Norton "Featherbed" frame is that it permits the use of a tank with a substantially flat floor, the weight of which is distributed evenly along the whole length of the top tubes. A single strap running along the upper mid-line is all that is required to hold such a tank in place, or it may even be retained by rubber bands attached to hooks on the underside.

When the frame design is such that the fuel container can be stowed away somewhere within it, the latter can be made cheaply and simply in two similar halves welded together. Ribs or depressions should always be pressed into the flat top and bottom, to tighten-up the metal and provide stiffness against "oil-canning."

Quite apart from these hollow and relatively lightly stressed articles which are ideal applications of presswork, it has long been the dream of many designers to make the whole frame, or at least its major components, in sheet metal and do away with built-up tubular constructions entirely. Few motorcycle factories in the past possessed the equipment necessary for producing pressings of complicated shapes and several square feet in area at an economical price, but there were a few attempts to do so, or to make a complete pressed frame by welding together several smaller sections.

One example of a complete pressed frame was the Royal Enfield "Cycar" of 1933, though this was so designed that the side panels were folded rather than pressed, the resulting shape being necessarily rather angular and not outstandingly attractive. Even before that time there was the Beardmore-Precision, composed largely of pressings welded together, the basis of the design being a petrol-tank which was, in effect, also the top tube. Another design of the 'twenties was the Ascot-Pullin, in which some attempt was made to attain a clean external appearance by employing a sheet-metal frame incorporating the petrol and oil tanks. Tank leakage developed in the Ascot-Pullin and was by no means easy to rectify—an argument in favour of separate tanks as used on the Ariel "Leader" and the LE Velocette, which are not subjected to frame stresses and are well protected in the event of a crash.

The LE's frame is composed of two major components, a front portion extending from the head to the rear of the power unit and a rear portion, essentially an enlarged mudguard, welded to the front and incorporating slots for the upper attachments of the rear springs, which are adjustable for load compensation. The seating accommodation is bolted to the top of this guard so that the crew's weight is supported almost directly by the springs, and the pivot-bearings for the rear fork are located in the vertical sides of the front portion, which is strengthened partly by local plates, spot-welded to the thin main pressing, and partly by a bolted-in bulkhead which also carries the rear end of the power unit.

At the front, the steering head is a built-up component attached by four widely spaced bolts to each side of the main pressing. Therefore, as in the region of the pivot-bearing, all major stresses are applied substantially in the plane of the sides—i.e., in the direction of greatest strength, a principle which is essential with sheet-metal if undesirable flexure and early fatigue cracking is to be avoided.

Although a tubular assembly is used to support the front end of the power unit and the radiator, the pressed frame is complete in itself. Making it in two portions reduces the size of dies required and, to obviate a difficult deep-drawing operation, the rear guard is made in two halves, welded along the centre-line. These are initially pressed in one piece which looks rather like a large wash-bowl. The centre is then punched out to form the inner radius of the guard and the pair of blanks are finally welded together along the edges which previously formed the outline of the pressing.

The front guard is formed in a similar way and is bolted to the fork-crown only, being sufficiently rigid in itself not to require the usual stays. Most mudguard blades are made by a rolling process and possess little transverse rigidity in shallow sections, though the addition of deep integral valances helps considerably in this direction.

The most advanced application of presswork in British contemporary design is the Ariel "Leader," in which practically every component, including the front fork blades, are fabricated from sheet, suitably reinforced where necessary at points of major stress.

The box frame is composed of two half-pressings, 20 s.w.g. thick, electrically welded along the centre line to form a very rigid structure. The appearance of this does not matter much because it is hidden from view by other (non-stressed) pressings of pleasing shape which blend well with the neatly styled tail portion, although the final appearance, to some eyes, gives an impression of heaviness which, however erroneous, is difficult to avoid in any design where the whole power unit is fully enclosed.

Swinging forks can be constructed (as in the Puch, to quote one example) by making each leg of two similar half-pressings, welded along the edges to give a tapered oval section. The fork-ends are made from steel plate, punched to shape and welded, and the two legs are joined by a cross-tube, close to and just behind the pivot-bearing. This cross-tube is not welded merely to the inner side of each leg, which would be to court almost certain disaster, but is passed through holes pierced in each side and welded to both. Under lateral loads, which tend to bend the whole assembly out of square, the stresses induced in the thin metal of the legs is mainly tension or compression, whereas if the welding were on the inner side only the metal would be subjected to intense local bending, with unavoidable flexure and eventual failure in that region.

Failure of this type is bound to occur in any sheet construction which is unthinkingly or unavoidably permitted or forced to flex at right-angles to its surface over a small area. Cracks will develop and radiate from rivet holes or around the bolt heads of components which vibrate laterally, and it may be necessary to reinforce such areas locally by the addition of large washers or shaped plates, which can easily be attached by electric spot-welding at several points without disturbing the temper of the steel to any great extent.

Stiffeners attached in this way should, however, always be placed so that the spot welds are not subjected to heavy tension, as they will sometimes pull through under that kind of treatment. Spot welding is performed by passing a very heavy current through the tips of two copper electrodes, which are squeezed powerfully against the outer surfaces of the parts to be joined. The current raises the steel to welding heat in a fraction of a second, and the clamping pressure completes the weld which is in the form of a spot about $\frac{3}{16}$ in. in diameter.

Spot-welded joints are not watertight, but the process is sometimes used to tack two components together at several points before gas-welding or bronzing. Small dimples are created in the surface, and the edges of the sheets are often rendered ragged or uneven by local flow of the metal; these two effects go towards making an unsightly job which is difficult and expensive to clean up.

In car bodywork, where the process is used very extensively, this difficulty is overcome by fitting a U-section capping strip, either of rubber or of some shiny metal. There are many places where this scheme can be used to advantage on motorcycles—as it is, for instance, on some B.S.A. tanks, which have two seam welds along the upper surface, covered by chromium-plated channel strip.

There is not much scope for presswork in conjunction with telescopic front forks, except for headlamp nacelles, or even smaller items such as lamp or speedometer brackets. With the more complex bottom-link varieties, however, good use can be made of sheet steel by forming it to enclose the links, either partially or fully, so going a long way towards making an inherently "bitty" design look neat and attractive, while simultaneously shielding the mechanism from road grit.

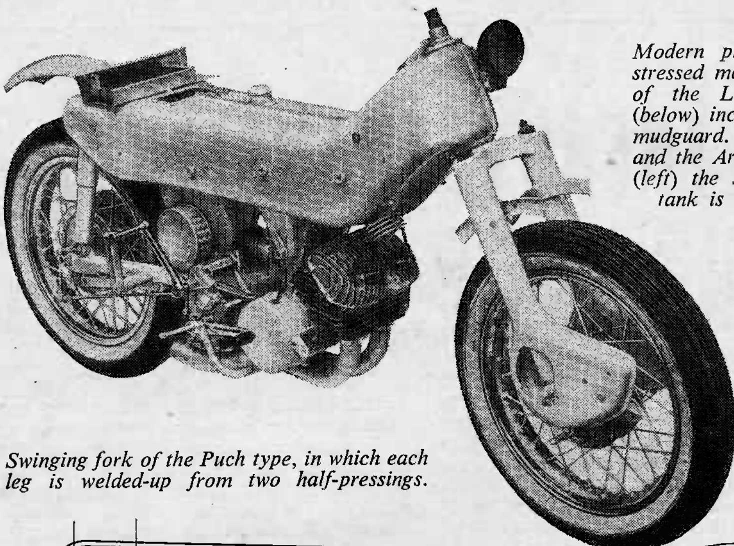
Reference has already been made to the "Leader" fork. This design is unusual, though by no means unique, in that the pressed blades are attached only to the lower end of the steering column, thus placing bending stresses upon this component to which it is not subjected when the blades are attached to both ends of the column, which is the more usual practice.

It does not follow that the idea is bad; it was used with great success on the very fast 120° Vee-twin Guzzi racers for several seasons. At first sight it appears that the column bending stresses would be extremely heavy during severe front brake application, but, by a fortunate combination of the forces brought into play, the stresses are not quite so great as might be imagined—a point which will be enlarged upon in a later article.

In the NSU leading-link forks, much of the mechanism is enclosed by pressings which are carried up and around the steering column, thus making a neat enclosure for what is normally an untidy area and eliminating bending loads at the base of the column.

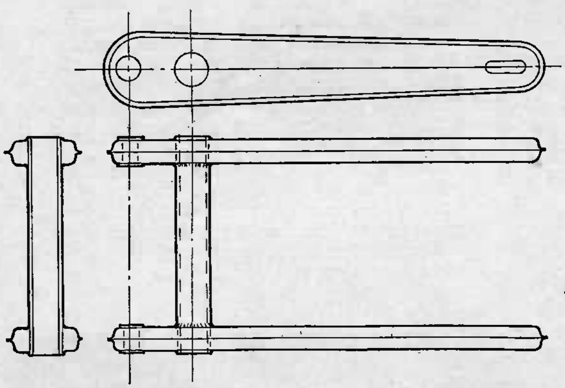
Many years ago pressed blades were used to replace the tubular assemblies of some girder forks on the score of cheapness, but the blades were merely of open-sided channel section of no great depth. Consequently, they flexed laterally in service and crumpled up in a heart-rending manner under even a minor sideways impact.

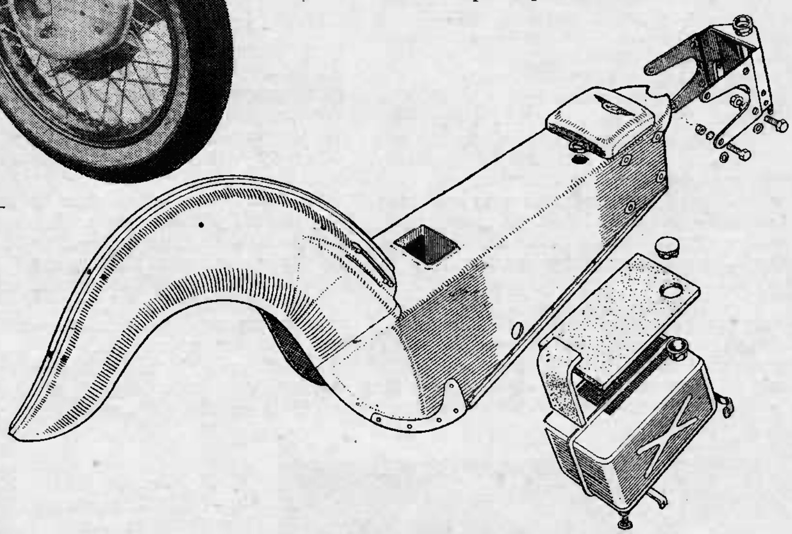
In contrast to these designs, where virtue was sacrificed upon the altar of cheapness, the original Francis-Barnett "Cruiser" of 1933 employed fork blades each made from a D-shaped pressing, with a flat back welded thereto to form a closed section of pleasing appearance and adequate strength in all directions. Although this type of fork is now obsolete, the examples are quoted to indicate how the intrinsic good qualities of pressed-steel work can be turned to advantage, while failure to realize its limitations can result in designs which, though respectable in appearance, are functionally weak.



Modern practice. The stressed main pressings of the LE Velocette (below) include the rear mudguard. In both this and the Ariel "Leader" (left) the separate fuel tank is unstressed.

Swinging fork of the Puch type, in which each leg is welded-up from two half-pressings.





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