MOTORCYCLE ENGINEERING—11

THE TAIL SECTION

Suspension, seating, styling — all are affected by "rear end" design

By PHIL IRVING

In the design sense it is not possible to separate the tail section from the main frame, as the two finally form a single assembly, but there are a number of minor points and one or two major problems which it is convenient to group under the general heading of "rear end."

It has already been noted that the tail structure must be able to carry 300 or 400 lb. weight on a touring model, and all this is overhung or cantilevered out from the centre section.

Lateral movement in relation to the main frame, although it does not affect wheel-alignment, is detrimental to good handling because of the jelly-like sensation it engenders. Even if such major oscillations do not occur, any overhung structure, especially if it is approximately of an inverted U section, is likely to vibrate in resonance with the engine at some speed, as demonstrated by the persistence and rapidity with which some mudguards have cracked under racing conditions.

The leverage exerted by the tail structure on the centre section can be reduced to a very small amount, when using a plain swinging fork, by running the spring-units almost straight up. It is advisable, however, to lean the top ends of the units forward so that their centre-lines shall be more nearly square to the radius drawn through the fork pivot to the mean centre of the units. This reduces the movement of the heavily loaded bearings of the units and indirectly improves their life, because there is then less side-loading applied to the small-diameter sliding spindles which keep the units in line and operate the hydraulic damping mechanism.

Since the units should take absolutely no part in maintaining wheel-alignment, soft rubber bushes are quite satisfactory. In any event it is desirable for both the upper and lower bearings to be of a type which are self-aligning in all directions without strain on the units, as there is bound to be a certain amount of malalignment existing at times between the extremities of the springs.

Once the location of the springs has been decided, the design of the supporting structure can be tackled. The most straightforward idea is to attach a tubular frame to the seat lug, extending back to the end of the dual seat, and brace it by means of a diagonal stay on each side, running from a point close to the top spring anchorage to another point adjacent to the pivot bearing.

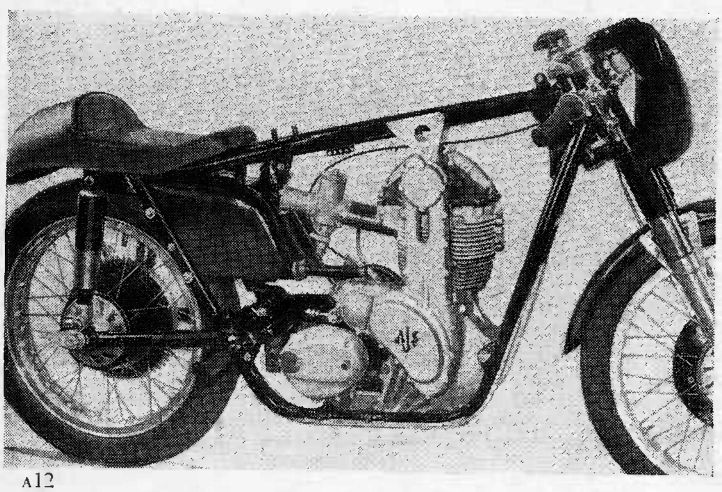
When this form is adopted on a wide duplex frame, such as the Norton "Featherbed," the structure is reasonably rigid laterally, though much of the stiffness in the "Featherbed's" case is derived from the fact that all four tube-ends are welded to the main structure. If the attachments are closer together, or composed only of bolts passing through flattened and drilled tube-ends, lateral rigidity may well be insufficient unless some additional cross-bracing is supplied to the tube forming the top run of the structure, such as by the addition of a built-in toolbox or by firmly uniting the mudguard and the tube.

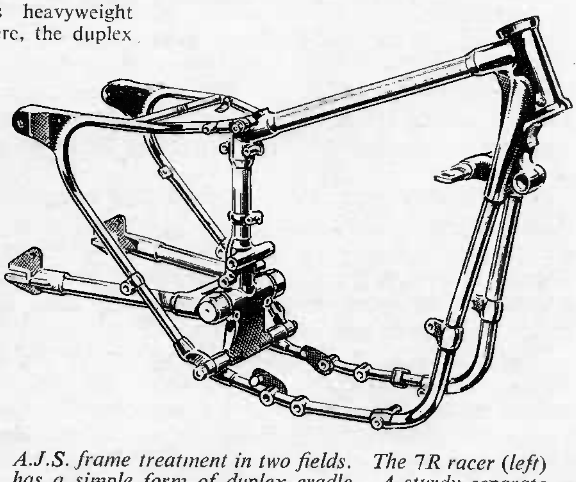
A logical development of the duplex cradle frame is to bend the two lower tubes upwards below the power unit and run them from there to meet rearward extensions of the top tube close to the upper spring mounting points. The fork-bearing can then be carried in a substantial lug at the lower end of the saddle down-tube.

A modification of this plan is seen in the new A.J.S. and Matchless heavyweight touring frame illustrated. Here, the duplex main frame is matched by a sub-frame formed of a single tube on each side, a "lazy V" in elevation, with the fabricated upper anchorage lug of the spring unit welded to the apex. The two tubes are united by a cross-brace below the seat.

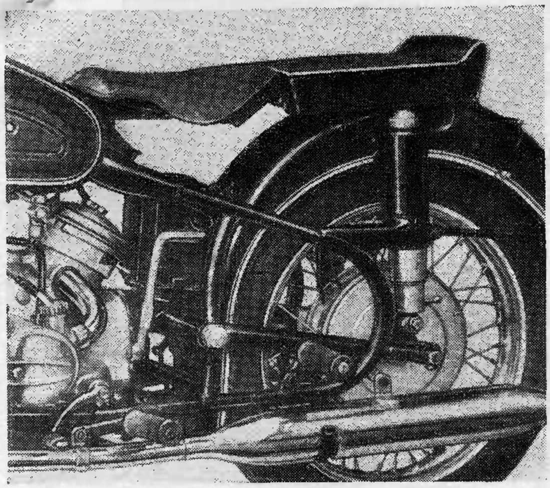
In the racing versions of the A.J.S., however, the down-tube is omitted and the pivot is carried directly on the cradle-tubes. This layout involves rather an extensive length of top-tube, and as the engine is steadied against torque reaction by a bracket which hangs below the tube approximately half-way along it, there is a distinct possibility that this member might be set into resonant vibration at some point in the engine speed range. Even at the expense of a couple of pounds extra weight, additional stays between the top tube and the pivot-bearing brackets might well improve this frame, as indeed some experiments have already indicated.

It is interesting to note that many years ago the Nimbus, of Danish origin, employed a frame which was basically similar in essentials, but in this instance the top member, which also acted as the petrol tank,

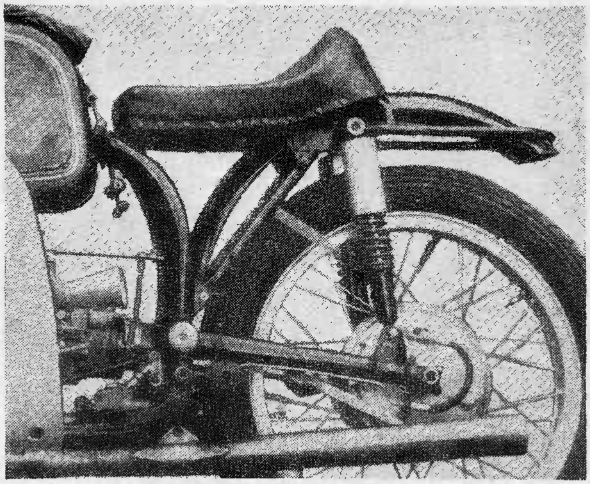




A.J.S. frame treatment in two fields. The 7R racer (left) has a simple form of duplex cradle. A sturdy separate sub-frame is employed in the 1960 heavyweight touring frame (above); a massive lug carries the fork bearing.



B.M.W. contrast. The main frame members of the R69 tourer (left), extending farther back than those of the racer (right), provide attachment points for pillion footrests and silencers.



was five inches in diameter, so that it would not be likely to suffer from vibration.

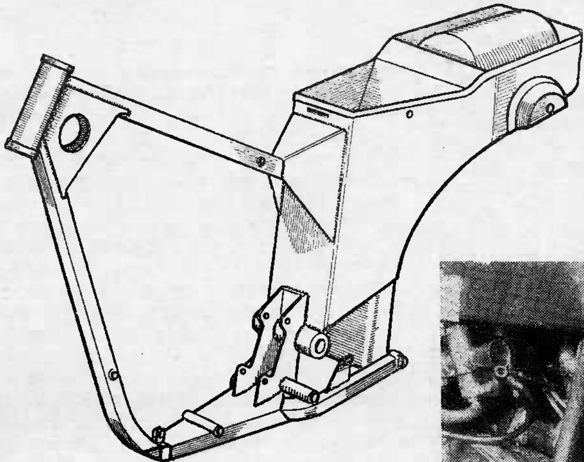
In addition to the methods described there are a host of others, such as the simple welded-up spring brackets used on the M.V. "four," by which the spring-thrust can be absorbed.

Broadly speaking, it is much simpler to arrive at a neat, effective design for a racing model than it is for a touring mount because in the former case one is catering for a single person only, instead of having to allow for two, both as regards seating and footrests. In fact, unless one is very careful, a potentially "clean" design may end up as an unsightly collection of bent tubes and brackets by the time that mountings for extra footrests, two silencers and the rear stand have been provided, as well as places for attaching a sidecar.

The racing and touring versions of the B.M.W. illustrate the way in which the matter can be approached from two directions. The racer has a duplex cradle frame with near-vertical down-tubes and a bolted-on seat frame and practically nothing else extending rearward behind the pivot-bearing. In the road model, however, the duplex tubes run back past the tyre, curve upwards just ahead of the axle and finally meet the end of the top tube near the saddle-nose. The pivot bearing is carried by two tubes bridging the angle and the springs are fitted within fixed housings which provide enough clearance to deal with the small amount of angular swing of the units as the wheel rises and falls.

All the additional mounting points are fixed to the bottom run of the tubes, which are braced by a gusset to a cross-member to give additional lateral rigidity. A sidecar mounting ball is provided on the right-hand side only. The extreme rearward location of this ball-joint must place very great bending loads on the tube, despite the bracing gussets, and from this aspect it would be preferable to move the mounting farther forward and design the sidecar chassis accordingly.

When the mudguard is fully sprung, it is desirable to make it deeply valanced, partly for cleanliness and partly to obviate the unpleasing gap which would otherwise exist between guard and wheel when the model is



(Below) A D.M.W. "composite" frame, with squared tubes married to a central pressed "box" which neatly accommodates various auxiliaries.

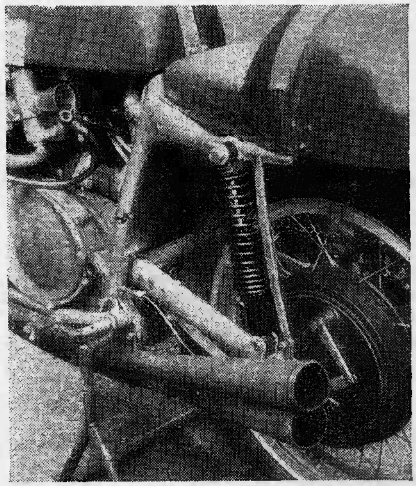
unladen. It is then but a short step from a framework supporting the guard to a sheet-steel structure which forms the guard and a platform on which the seating accommodation can be placed.

This may take the form of a separate unit, strong enough in itself to be fixed directly to the main frame, or may be more in the nature of full enclosure applied over the top of a framework. In this way, it is possible to clean up the whole appearance of the rear end, with little additional weight, especially as toolboxes, battery-compartments or even the air cleaner can be let into recesses in the sheet-metal work and smoothly covered with flush-fitting lids or by a hinge-up seat cushion.

This is one of the fields where the stylist can be allowed a certain amount of scope. It is necessary to achieve smoothly flowing lines without a bulky appearance, as bulk to many people implies heaviness as well; also, it is all too easy to finish up with a model consisting of two utterly contrasting styles, with the front end looking about 10 years out of date compared with the rear.

Ease of wheel removal presents a problem. The best course is to make the rear end of the mudguard portion either hinged or completely detachable—preferably the former, because there is then no need to detach the wire running to the tail-light. Whichever method is preferred, it is not too easy to

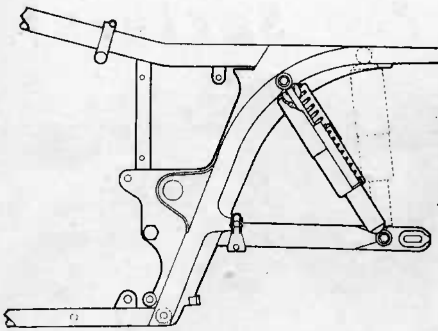
(Below) On the M.V. "fours," welded-up cantilever brackets carry the upper suspension pivots. Note the three-rate spring.



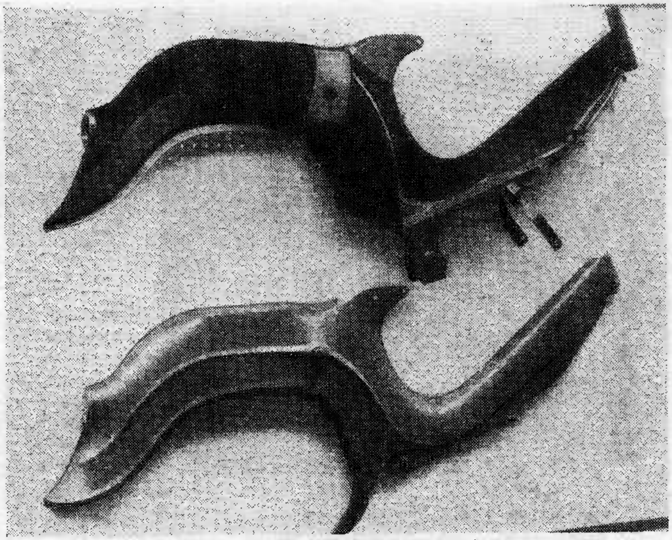
provide a joint which will remain rattle-proof and watertight indefinitely, and nothing looks much worse than streaks of mud sullying an otherwise clean surface.

Further, the presence of the joint weakens the structure to a considerable degree, and if this is in fact a stress-bearing member and not just an added enclosure it is necessary to reinforce the section locally with a welded-in pressing to prevent the sides of the U from spreading under load, which in turn would allow the tail section to vibrate vertically, especially if its mass were increased by a number-plate and tail-lamp.

Provided that the stand has enough lift to permit the wheel to drop to the full extent of its travel, it may be possible to remove it from the side without much juggling if the valance is not too deep, but if the valance is very deep the rider may have to lean the



(Left) The "seat tubes" themselves are produced to form a cantilever support for seat and suspension pivots in this modern Guzzi lightweight frame.



(Right) The simplest treatment of all—two pressings form the complete frame and "rear end" of the Dutch Magneet moped.

machine to one side and hold it there with one hand whilst extracting the wheel with the other—a feat which may well be beyond the capabilities of some individuals.

Since tyre trouble, though rare, almost invariably occurs at the most inconvenient moments, it is in the rider's interests to go to some pains to make wheel removal as easy as possible under all circumstances, which might include the presence of heavy pannier bags. All in all, the hinged guard is probably the most convenient system, though the Norton idea of providing a slot closed by the number-plate is quite good.

When a pressed-steel frame of the backbone or spine type is used, making the end of the guard separate is a natural thing to do, because it reduces the length of the main pressings and enables them to be blanked out of sheets of more economical size and with less waste of material. Also the press-tools are much smaller, and since their cost goes up roughly as the square of the general dimensions of the part being manufactured the tooling cost is lessened considerably. Admittedly, additional tools are required for the tail-piece but this can be made from a single pressing of relatively small size, and possibly of lighter-gauge material.

However, opinions differ on this point and some makers, especially in Italy, prefer to use two complete half-pressings, welded together, particularly for the lightweight class of machine where every ounce of extra weight makes a difference.

A subject which must be given consideration at the design stage is the amount of sprung movement which the rear wheel is to have. For various reasons, the movement has perforce to be reduced below that necessary to absorb the largest bumps in full—partly because, if this were done, the increase in head angle and trail which would result when the rear springs were fully compressed and the front ones fully extended might adversely affect the steering at a critical moment, especially on short-wheelbase models. Also, as the clearance of the crankcase or the lower frame members above ground, and that of the mudguard above the tyre, must both be fixed in relation to the "full-bump" position, a large spring-range is inclined to give rise to an unduly high and ungainly appearance when no rider is on board, and unfortunately it is in this state that the lines of a model are usually judged.

The point is of no importance for trials and scrambles models, where functionalism is more important than good looks and a high ground clearance is better than a hole in the crankcase. Quite apart from pure appearance, however, a high unloaded seat position makes it difficult for small persons to support the model with both feet on the ground when stationary, though of course the wheel diameter exerts an influence in determining the final seat height.

The question of how high the seat should be is one which has been debated for years. At one time there was a craze for ultra-low seat, achieved by frames which ran almost straight from the head to the rear axle, and even after it had been proved that such lowness was not only uncomfortable but undesirable the phrase "very low saddle position" reappeared annually in publicity material.

Trials riders go to the opposite extreme using heights which enable them to stand upright on the footrests easily. Raising the centre of gravity of the rider also helps in another way, which is analogous to the actions of a juggler balancing a plate on top of a stick. This is easier to do with a long stick than with a short one, because the plate, being so far away from the juggler's hand, remains almost stationary in space, while the lower end of the stick is moved about to maintain the edifice of equilibrium. Similarly, when a rider is poised high the wheels can veer from side to side when forced to deviate from the straight by gutters or stones, without much tendency to move the rider's centre of gravity.

In normal use, some consideration has to be given to comfort and convenience, especially in view of the fact that human beings vary not only in height, but in their proportions. This can be accommodated to some extent by adjustable footrests, but there is a limit to how far these can be moved without introducing the serious hazard of grounding on corners. As previously noted, the outer ends of the rests must not protrude beyond two planes drawn at 45° to the maximum upward wheel positions if this possibility is to be avoided.

Generally speaking, a saddle height of 30 to 31 inches is a reasonable compromise which seems to meet most conditions, both as regards stability and the stature of the rider. The modern trend towards fixed dual seats has almost eliminated one of the virtues of the old-pattern saddle—adjustability for height; although there is no reason why even a dual-seat top could not be made with a possible variation of one or two inches.

The practical aspects of construction are discussed in three articles on "Materials and Methods," the first of which appears next week.