

SUSPENSION EX

There's not a single item on the modern MX motorcycle that's receiving more attention these days than rear suspensions. Yamaha seems to think that if two shocks are good, one is better. Let's look at their Monoshock and find out why.

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PLOSION



BY DAVE EKINS

Is one really better than two? Well, Yamaha and Mister Tilkens think so. Who's Tilkens? Oh, he's a Belgium guy who has the patents for a single shock absorber mounted under the gas tank. You know, the new Yamaha Monoshock system.

It's curious that Tilkens developed this idea on a Husky, tried to sell it to Suzuki, and it ended up on Yamahas. What's more, we'll probably be seeing Monoshock YZs as part of the '75 line from Yamaha.

Somewhere along the line certain European professionals felt if they had as much wheel travel on the back as they did up front they could ride faster. Problem is you only get about 4 inches of travel out of a 13-inch long shock. Normal practice was to mount the shocks close to the axle where their work would be minimized, use 70-pound rated springs, and ride with 4 inches of rear wheel movement.

Then, in the beginning of the '73 moto-cross season, factory Maicos were seen with Bilstein shocks mounted mid-way up the swing arm. (Bilsteins are a gas-operated shock common on race cars and are not affected by heat the way normal units that rely on hydraulic fluids are.) These Maicos had 5½ to 6 inches of travel at the axle, nearly equalling their 7 inches of front fork travel. They were smooth and fast just as long as the Bilsteins held out, usually less than one race. We don't know why, we only know the gas shock didn't work. Shortly thereafter Konis were being used in the same position as the Bilsteins, only these were Koni inners slipped into finned aluminum alloy housings that offered greater fluid capacity in addition to cooling.

With the shocks moved up the swing arm they are required to control over 6 inches of wheel travel instead of the 4 they were designed for. This energy from the bouncing wheel is converted into heat by the shock which, when overworked, turns the hydraulic fluid into a waterlike consistency. Lubrication and damping goes away.

The sand moto-cross courses in Belgium and Holland are the most punishing for both rider and bike. It not only takes lots of horsepower to force a bike through wet sand, but suspension is constantly worked to its limits on the undulating track too. And if the rider is not up to this type of workout, forget it.

Yamaha's Monoshock had its first success with Hakan Andersson at the Belgium G.P. where he scored a second and first for the day. The following two races, one in Czechoslovakia, the other in Poland, Andersson won four consecutive races. During the '73 G.P. season the Yamaha ace won 11 of the 22 races—a record.

Hakan's Monoshock had two things going for it, 6.9 inches of well-controlled travel at the rear axle and almost total reliability. Even so, there are negatives to this scheme. Due to their construction, the swing arm and shock unit are heavier than conventionally sprung crossers, and the shock is mounted above the engine, detracting from a low center of gravity. But don't tell Hakan; he won the World Championship going away.

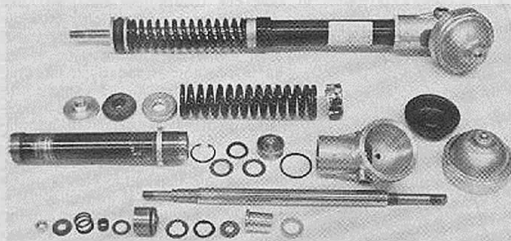
You have to change your riding style to adapt to 6-plus inches of travel at the rear axle. On the normal racer an

inch of vertical movement at the axle changes the fork angle approximately one degree. The professionals are sensitive to half a degree change in steering head angle so you can imagine what six would do to you or me. This is why you see the pros slide up on the gas tanks to turn; it effectively gives them a steeper angle.

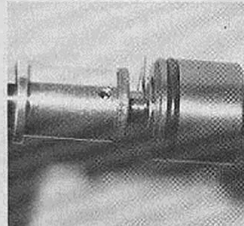
They say the Monoshock keeps the back wheel on the ground 25 percent more of the time than normally suspended racers. If true, this has to be where the advantage lies; you can go harder and stop better when the wheel



The monoshock unit itself is well hidden within the Yamaha triangulated frame. Steering head area had to be reinforced to withstand loads.



All these bits and pieces properly fitted together will make one complete monoshock, top of photo. Long-travel unit is designed to control the rear wheel under severest of moto-racing conditions.



Piston uses O-ring for seal, wafer spring end washer locate on shoulder. Hole in sleeve is fluid route..



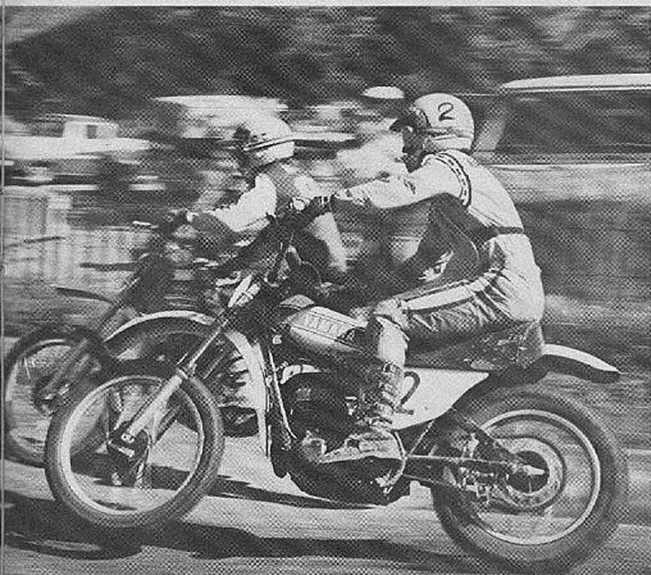
Nut holds piston in place, allows clearance for washer and wafer spring which act as one-way valve.



About 50cc of hydraulic fluid are poured into cylinder before piston slides completely in. This is 20w Lubritech fork oil.



Foot valve fits into housing half before cylinder is screwed into place. O-ring precedes valve acting as seal between casting and cylinder.



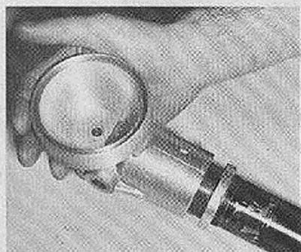
When you ride a Yamaha endurance racer

is on the ground. Watch a mono-shocked Yammie accelerate down a bumpy straight: only the driving wheel is following the ground, while the front is half a foot in the air. The rider isn't bouncing around and he's not shutting off, and the whole thing is going straight and fast. Other 'crossers with similar travel do nearly the same thing; it's all in having equal movement at both ends of the motorbike. What is a monoshock? We'll put one together for you so you'll learn what we found out while digging out our story. But first, a little dialogue.

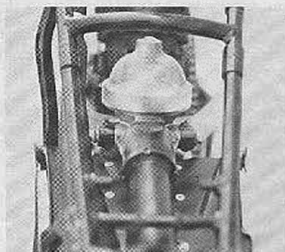
A single monoshock unit is a couple pounds heavier than a pair of shocks on the back of your bike. Both shocks have to have a place to store the hydraulic fluid that is displaced by the piston and shaft as it sinks into the shock body. Common shocks have an air cavity that allows compression of air as the hydraulic fluid is moved into it when the shock compresses.

Some shocks, particularly those that have not been filled properly, will end up with an air-oil mixture, foam. The monoshock doesn't have this problem because it has a neoprene diaphragm that separates displaced hydraulic fluid from compressible nitrogen gas. As the shaft fills the shock housing during

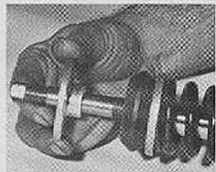
Left: Suspension really gets a workout on the moto-cross track. Here Karsmakers takes a straight line through the holes to pass.



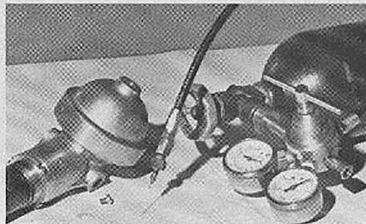
Above left: Cylinder screws into lower half of housing bottoming against footvalve and O-ring, jam nut secures joint. Above right: Remainder of fluid goes into shock with piston fully extended. Diaphragm mates to groove in housing, displacing air and excess fluid.



Rear of monoshock has a steel sleeve fitted into aluminum casting. Upper portion of swing arm is fastened by lightweight titanium bolt.



There's a 1/2" preload on main spring; aluminum retainer, donut and washer make up cushion, holding spring in place. Machined flat on shaft is so you can get a wrench on it.



Pressure regulator is essential in supplying the required amount of nitrogen to the monoshock. Hollow needle penetrates a neoprene valve.



Upper frame tube is boxed-in steel stampings specially designed for monoshock suspension system.

Yamaha may have the answer, but here are 16 alternatives.

1-4. Four Maicos appear to be the same. Closer examination reveals each to be very different, gusseting on swing arms are most varied. Shocks appear to be Konis slipped into a number of different outer housings. Chain guides are a must with this much wheel travel.

5-7. Upside-down shocks are also being tried. Large-diameter pair on Kawasaki are Ceriani while Bul and Penton are fitted with Bilstein gas operated units. Bent arm on Penton was made that way at factory, note boxed-in gusseling and original shock mounting holes. The game is still in its infancy with people trying everything.

8. Strangest of all current experiments is this three-legged Can-Am racer, belonging to Gary Jones. Forward mounted Konis have additional benefit of single shock less spring mounted on this side only.

9. Honda Elsinore uses heavily gusseted aluminum swing arm with unique sturdy axle slot. Konis are mid-mounted, fender upped for clearance.

10. These are Boge shocks mounted at an exaggerated angle. Swing arm does not require additional gussets but loading on shocks during compression becomes strange. This design does not offer travel some of the others have.

11. Another Honda Elsinore, only this one utilizes the standard upper shock mount brackets. Koni has been moved mid-way up swing arm for additional wheel travel but reverse slant will cause shock to work against itself.

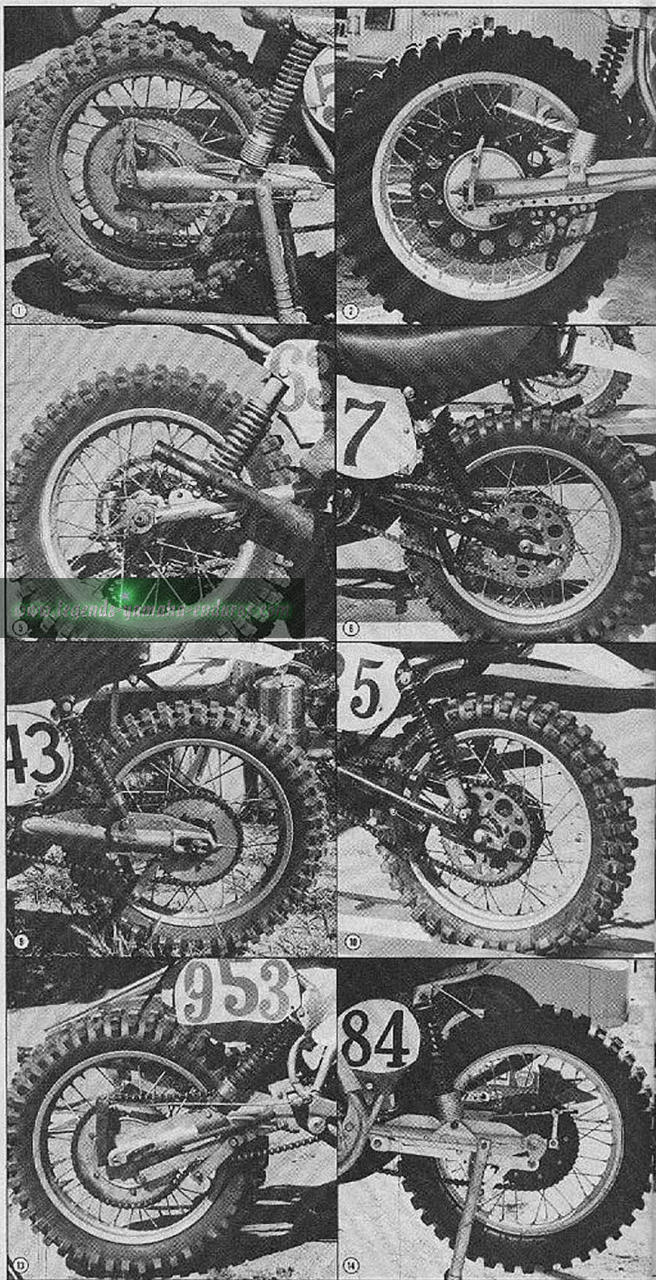
12. Normal YZ Yamaha has Profab swing arm installed and Konis in place of Yammy's overweight standard shocks. Arm is chrome moly, generous gusseling.

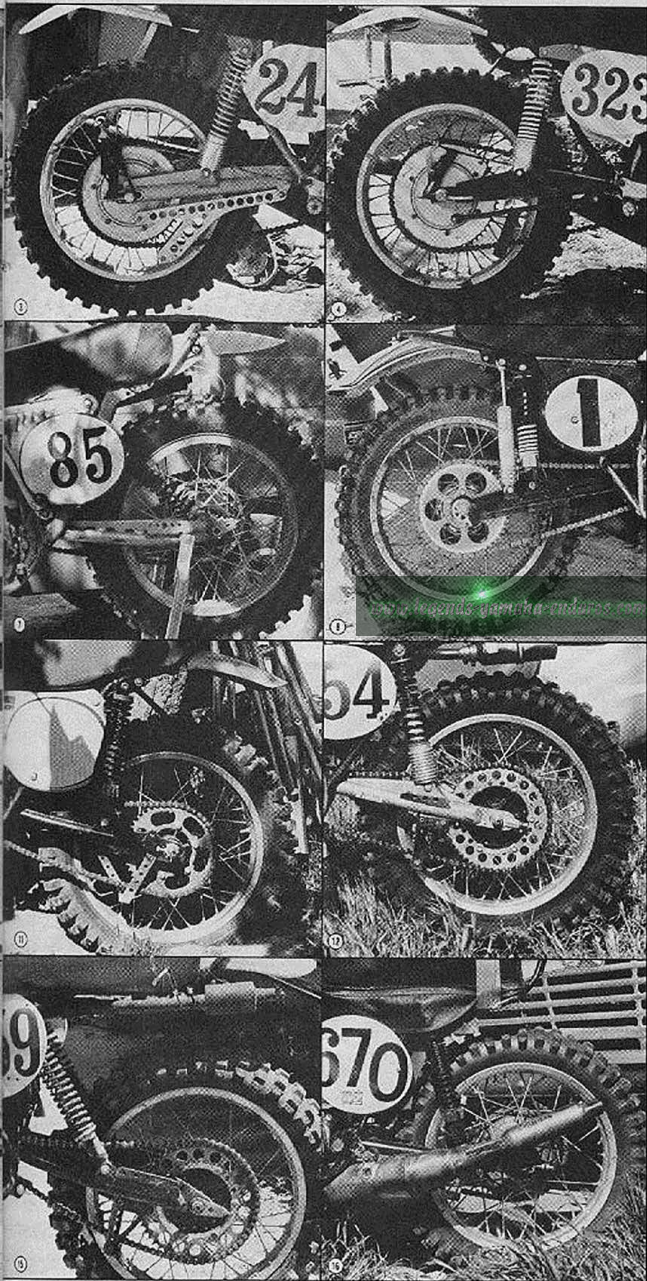
13. When you gain an extra 2 inches of travel it generally means an extra inch down as well as up. Chain tensioner helps keep sloppy chain on tracks but this is ridiculous. Extreme angle of Koni shock should create problems.

14. Clean Bul is using finned Konis, probably 110-pound springs. Chrome moly swing arm is standard, gussets added. Brake rod is aircraft cable.

15. Another forward sloping Yamaha. Sagging chains are just one of the problems faced by those who are hanging their shocks up front. Notice 4 other shock mounting holes, evidence of this tuner working his way up to the swing arm pivot.

16. Even the basic old CZ is not immune to the fiddler's whims. Mid-mounted Koni is the cleanest of all the examples we've presented here.





a normal compression stroke, excess fluid is shoved into a cavity that is filled with nitrogen. There is absolutely no air within the monoshock.

The monoshock piston has 170mm of travel, allowing the rear wheel 190, that's nearly a 1 to 1 ratio. Current production 250CR Huskys have 3.3 inches of shock travel and 5.5 at the rear axle, putting nearly twice the work load on the shock and spring. (Having two doesn't alleviate the situation because the shocks were intended to work in pairs in the first place.) Another advantage of the single unit is it doesn't have to match up with the one on the other side of the rear fork.

Full hydraulic control of the piston in both directions with a progressive hydraulic resistance at the two extremes of the stroke is common shock practice. Yamaha pulls it off well, allowing the single spring to coil bind just before the shock reaches full compression. It's a heavy spring and is installed with about 1/2 inch of pre-load.

During the development of the monoshock by Yamaha various orificing similar to carburetor main jets were used in two places to control fluid flow. Once they arrived at the desirable combination, these two metered sizes became a part of the shock; they're not adjustable anymore. One controlled the flow of fluid on compression, the other in rebound.

A more sensitive damping variation is still possible with the monoshock simply by using various nitrogen gas pressures in the housing. Normal setting is 280 psi, and they have varied this as much as 50 pounds in either direction with noticeable results.

A monoshock lives a lot longer than normal shocks that have been repositioned up the swing arm in order to get the same long travel. Karsmakers' unit is said to have gone the whole Trans-Am series without failure. This is not to say the part is foolproof. Anything mechanical can fail. Yamaha has had a water spring in the foot valve crack, probably damaged in assembly or the result of poor heat treatment in its making. They've also ruptured a couple of diaphragms. But this was during development. Track record for the production units still remains to be established.

The high mounting position of the shock makes it necessary for the swing arm to be of triangular construction. It weighs more than your conventional arm. The front of the frame has also been redesigned, not only to mount the shock but also to take the loads transferred from the back wheel.

Where all the other bikes have been chopping and fitting in an effort to position shocks for greater travel, Yamaha designed a whole new chassis to accommodate theirs. Now I ask you, isn't this a step in the right direction? ●