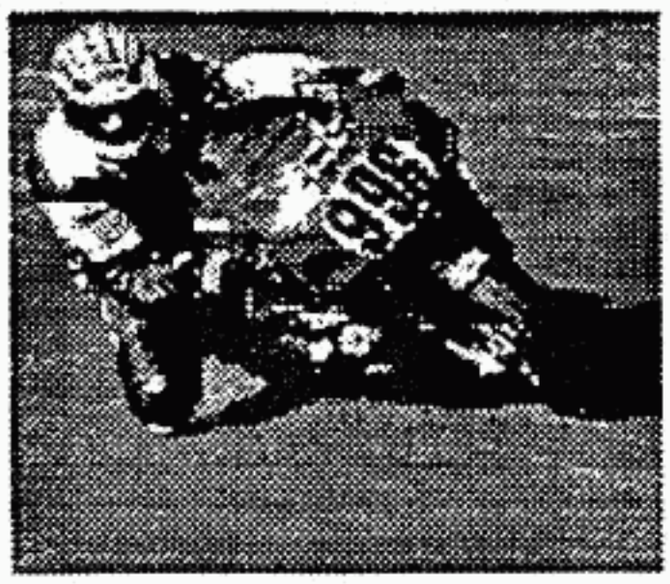
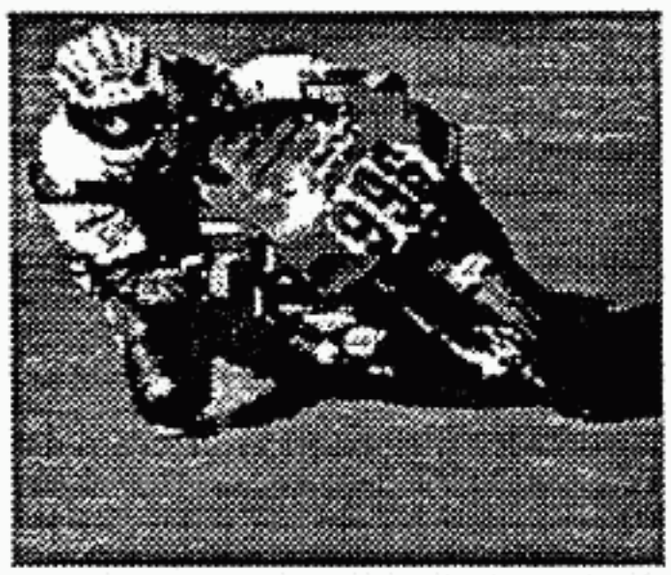


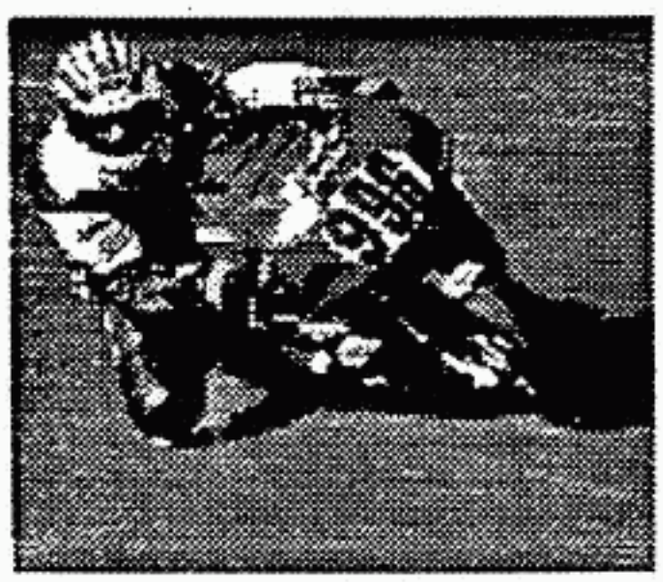
SPORTBIKE BASIC SUSPENSION SETUP SEMINAR

(Part 2)



SPORTBIKE BASIC SUSPENSION SETUP SEMINAR

(Part 2)



SPORTBIKE BASIC SUSPENSION SETUP SEMINAR

(Part 2)

PREPARED & PRESENTED BY: GARY JAEHNE (AFM #996)

For any additional questions or comments on this presentation: EMAIL address: GSJCB1@AOL.COM

SUSPENSION SEMINAR COURSE (PART 2) OUTLINE

I: Student Welcome / Instructor Introduction

II: Review of Class Schedule

III: Review of Part 1 Topics (student questioning)

IV: Compression / Rebound : "Removing the mystery"

V: Hands-On Demonstration (Compression/Rebound)

VI: Advanced Suspension Tuning: "Beyond the factory settings"

VII: Common Bike Handling Complaints: "Troubleshooting"

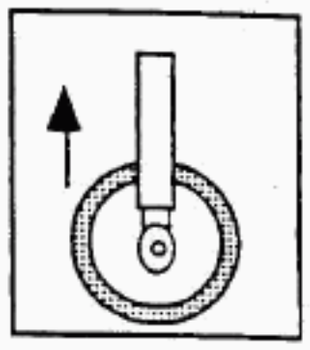
VIII: Open Question/Answer Wrapup

***** ADJORN*****

SUSPENSION DAMPING TERMINOLOGY SHEET

COMPRESSION DAMPING

The amount of hydraulic resistance provided within the shock or forks, caused by restrictions in the internal oil flow, when the wheel is moving upwards towards the chassis (bumps).



- **HIGH SPEED**

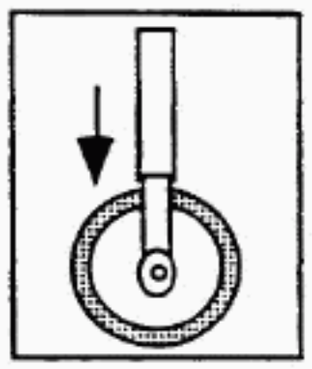
The amount of hydraulic resistance provided within the shock or forks, when the wheel is moving QUICKLY upwards towards the chassis, as a result of sharp edged bumps or dips in the road surface. (Normally internally controlled only)

- **LOW SPEED**

The amount of hydraulic resistance provided within the shock or forks, when the wheel is moving SLOWLY upwards towards the chassis, as a result of suspension loading when entering turns, or rolling changes in the road surface. (Externally adjustable)

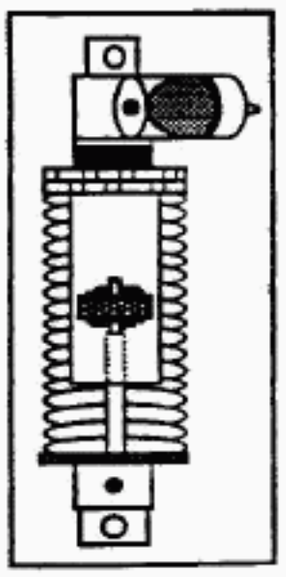
REBOUND DAMPING

The amount of hydraulic resistance provided within the shock or forks, caused by restrictions in the internal oil flow, when the wheel is moving AWAY from the chassis. This form of damping provides the necessary resistance to movement for the stored energy contained in the compressed spring, during fork extension. Increasing spring rate selection, will effect required damping capacity. Most noticeable effects occur on the recovery side of bumps and when cresting over the top of rises in the road surface.



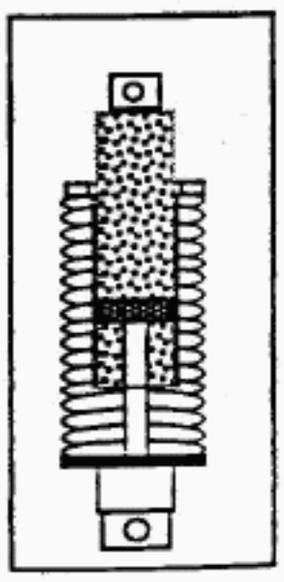
DE- CARBON STYLE SHOCK

A design of damping mechanism used in most modern sportbike shocks, containing a remote reservoir, in which pressurized gas allows for the expansion of the moving oil caused by the internal piston's travel. The oil is isolated from this pressurized gas, by way of a sealed rubber bladder, to prevent "frothing" of the oil. This system offers more precise operation and superior control of damping rates under extreme racing conditions.



EMULSION STYLE SHOCK

A design of damping mechanism used on older / low cost shocks, in which the oil and the gas inside the shock are not separated, as they form an "emulsified" mixutre. This emulsified mixture allows the necessary expansion for shock piston shaft travel into the enclosed chamber of the shock body. This system lacks precision control at varying suspension travel speeds, and tends to lose some of its effectiveness when subjected to the heat of high stress conditions.



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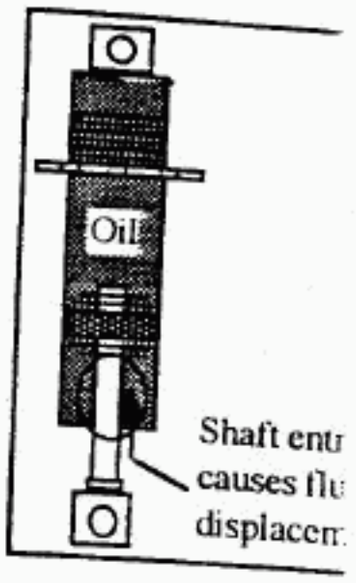
SUSPENSION DAMPING TERMINOLOGY SHEET

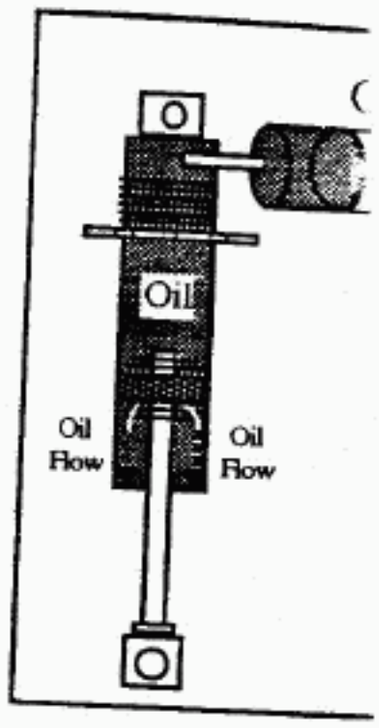
HYDRAULIC LOCK

A situation where there is no remaining space inside the enclosed chamber of the suspension tube to accomodate the increased displacement of the suspension fluid (oil), resulting in a sudden lack of additional piston travel ("lockup").



SINGLE TUBE DESIGN

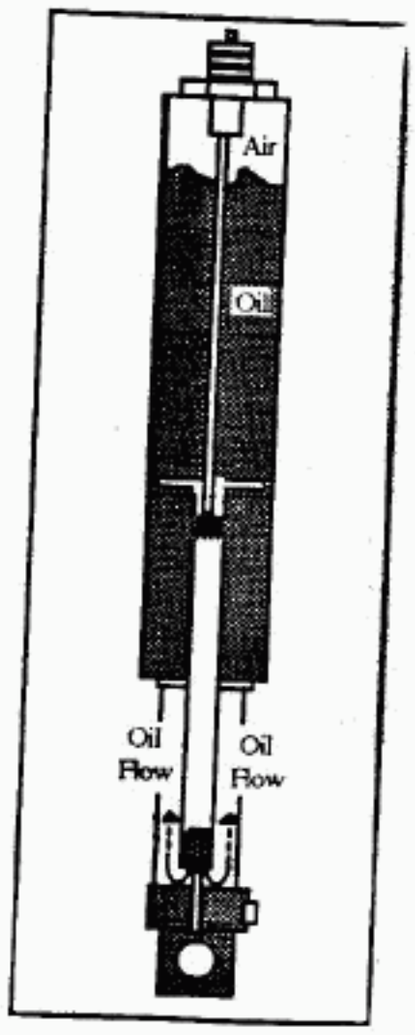
A design of damping mechanism where the oil is passed directly across the openings in the actual piston, to provide for the necessary fluid transfer during suspension travel. The suspension fluid (oil) is typically totally isolated from the air/gas chamber expansion chamber area. (Rear Shock)



Single Tube Desi
(Shock)

DOUBLE TUBE DESIGN

A design of damping mechanism where the oil is sealed from passing through the actual piston (other than "low speed" action), and travels through a transfer port at the end of the damping tube (restricted by a check valve with shims), and into an outer fluid chamber (in which there is an accompanying volume of air).
(Front Forks)



Double Tube Design
(Forks)

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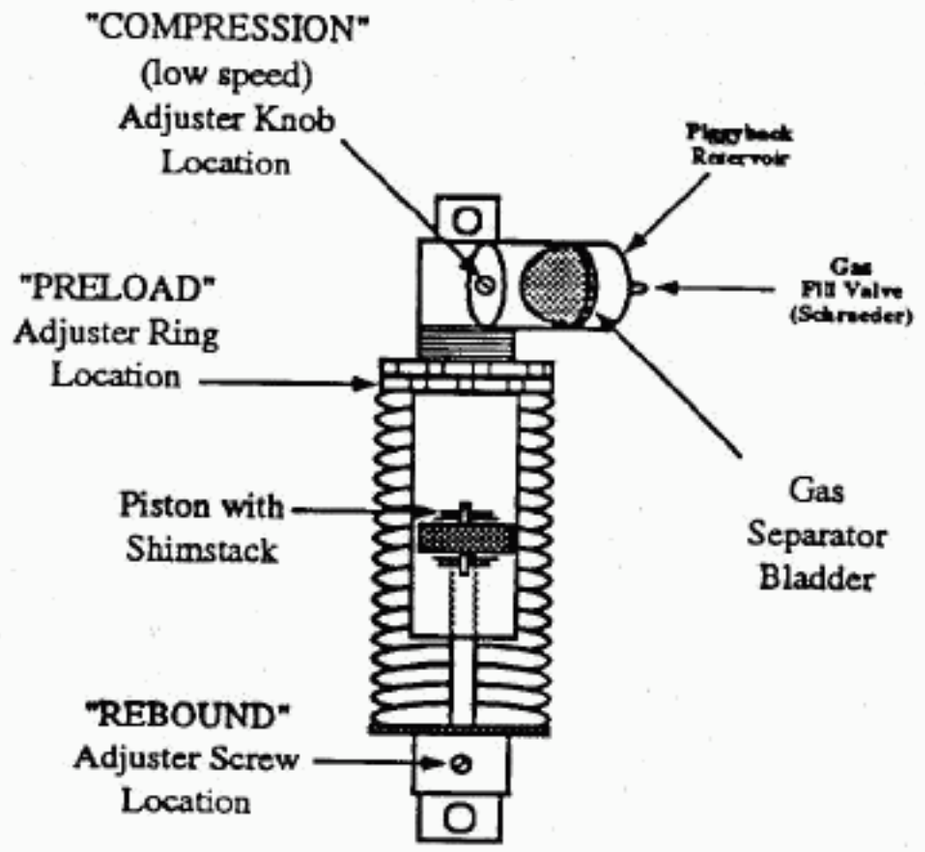
SUSPENSION INTERNALS & ADJUSTMENT LOCATIONS

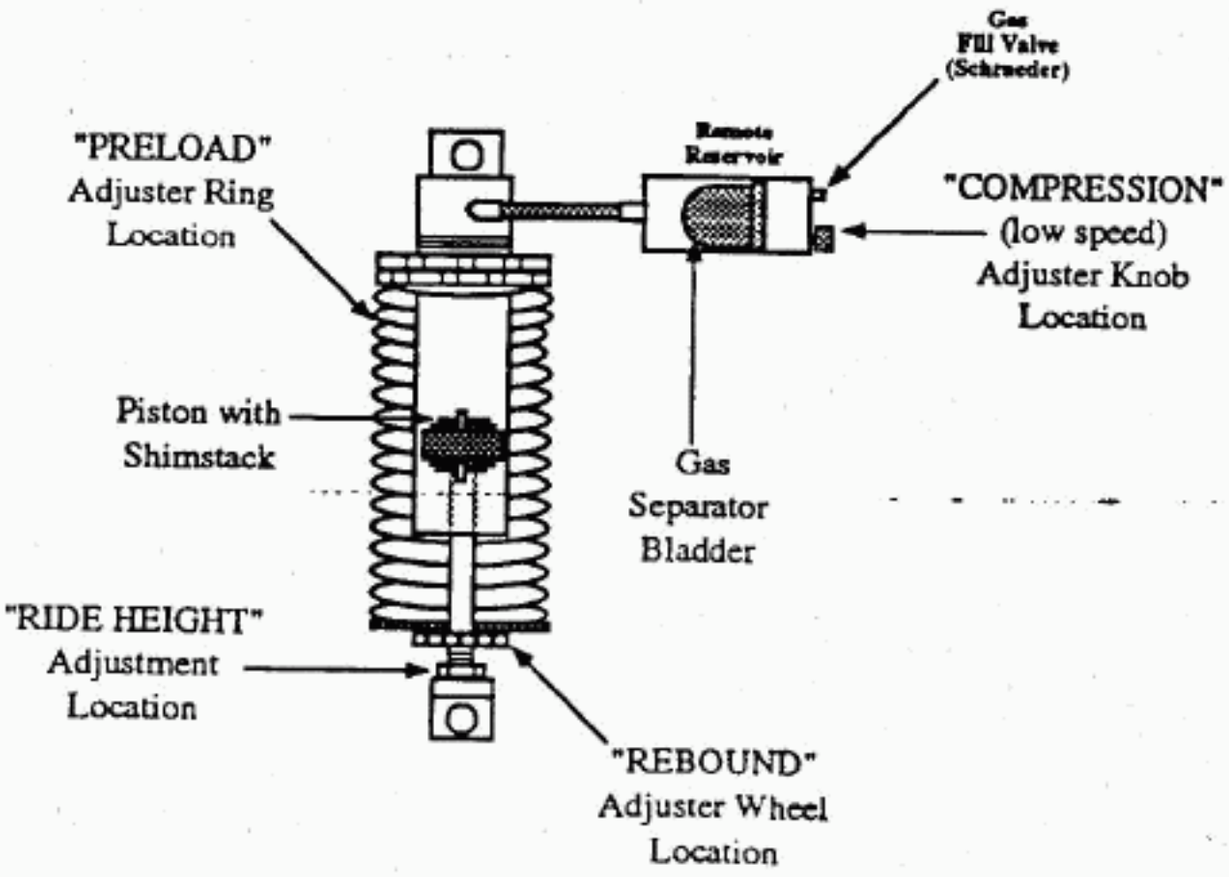
REAR SHOCK

Typical Modern OEM Piggyback Shock

need gas because gas compresses, and shaft displaces oil.



Typical "Aftermarket" Shock



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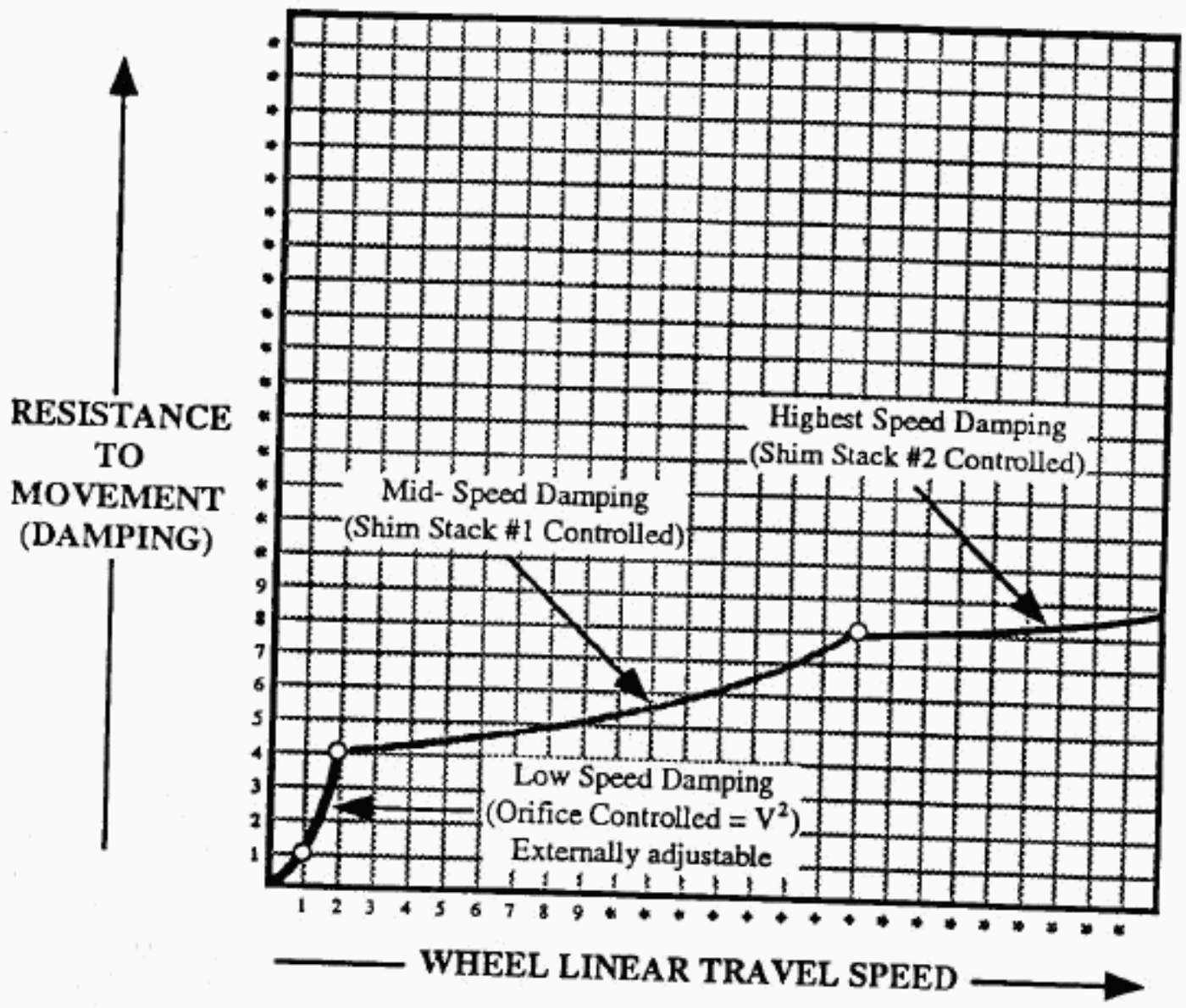
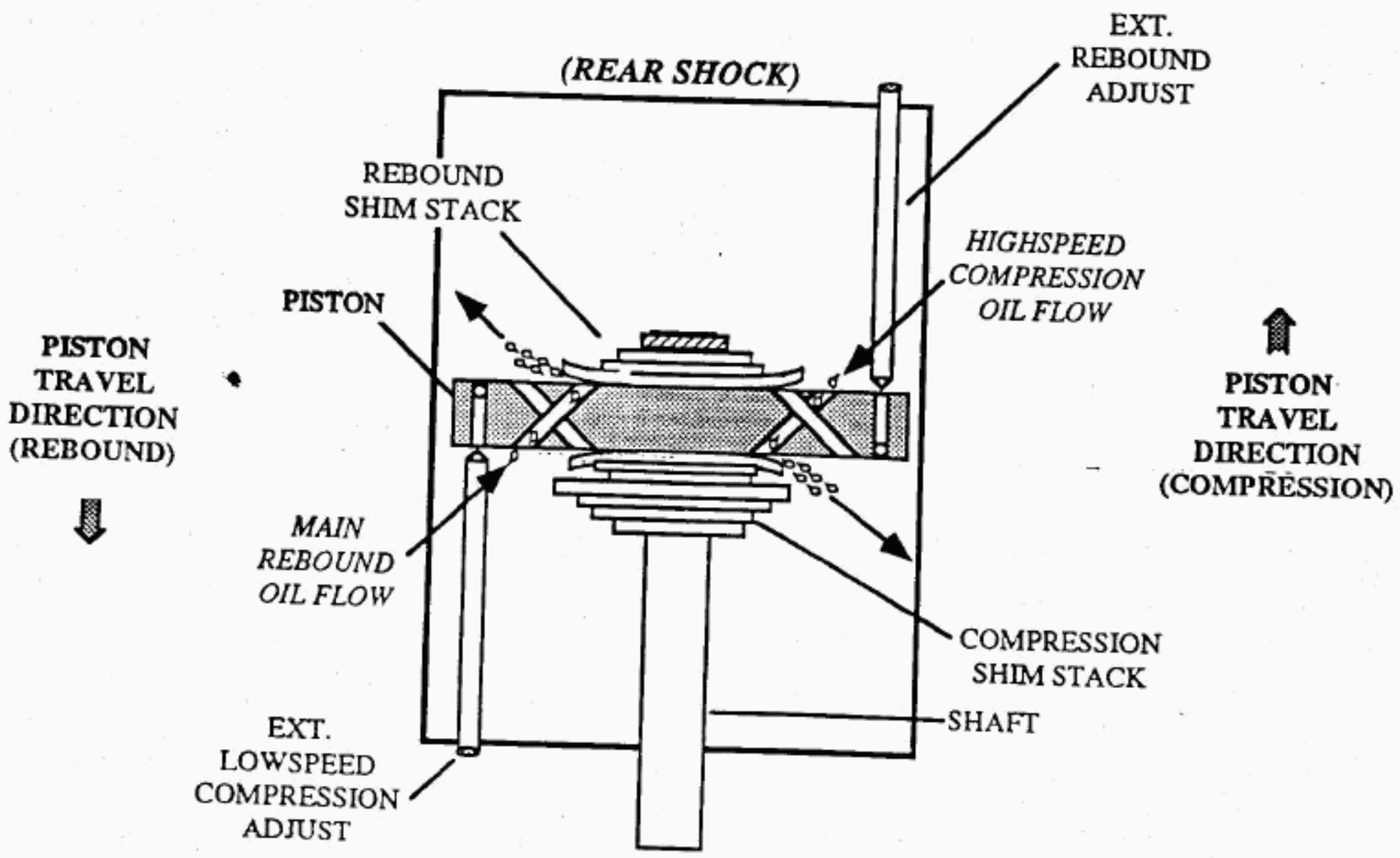
DAMPING OIL FLOW CONTROL CONCEPTS

COMPRESSION DAMPING CURVE



DAMPING OIL FLOW CONTROL DIAGRAM



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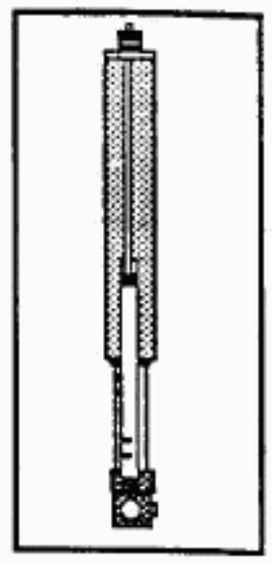
SUSPENSION DAMPING TERMINOLOGY SHEET

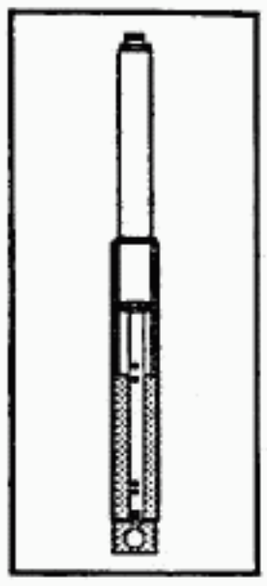
CARTRIDGE FORK

A design of damping mechanism used in most modern sportbike forks, consisting of an enclosed metal tube, internal damping rod with piston and tunable oil flow control valves. This system offers more consistent operation and superior control of damping rates at varying suspension speeds.



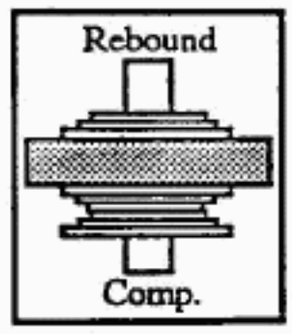
DAMPING ROD FORKS

A design of damping mechanism used in older / lower cost motorcycle forks, consisting of a damping rod solidly mounted to the bottom of the fork slider, containing a plunger that rides on the inside of the surface of the actual upper fork stanchion tube. This system utilizes a rather crude method of simple hole orifices, to control damping oil flow.



SHIM STACK

An array of stacked thin (i.e. .010") washers, of varying diameters and thicknesses, that control the rate of oil flow through the orifices of the piston (inside the suspension's internal chamber) when the suspension is moving at higher speeds. Separate stacks exist for control of "compression:" vs. "rebound" damping.



V^2 DAMPING FORCES

The damping force (resistance) through a fixed size orifice, increases at the SQUARE of the increase in actual piston speed ("Velocity").

FORMULA: $\left(\frac{VA}{VI}\right)^2 \times (FI) = FR$ *(Force Resultant)*

		Piston Speed				
(Velocity Initial)	*(VI)*	1"/Sec		100 lb.	*(FI)*	(Force Initial)
(Velocity Accelerated)	*(VA)*	2"/Sec		400 lb.	*(FR)*	(Force Resultant)
(Velocity Accelerated)	*(VA)*	3"/Sec		900 lb.	*(FR)*	(Force Resultant)

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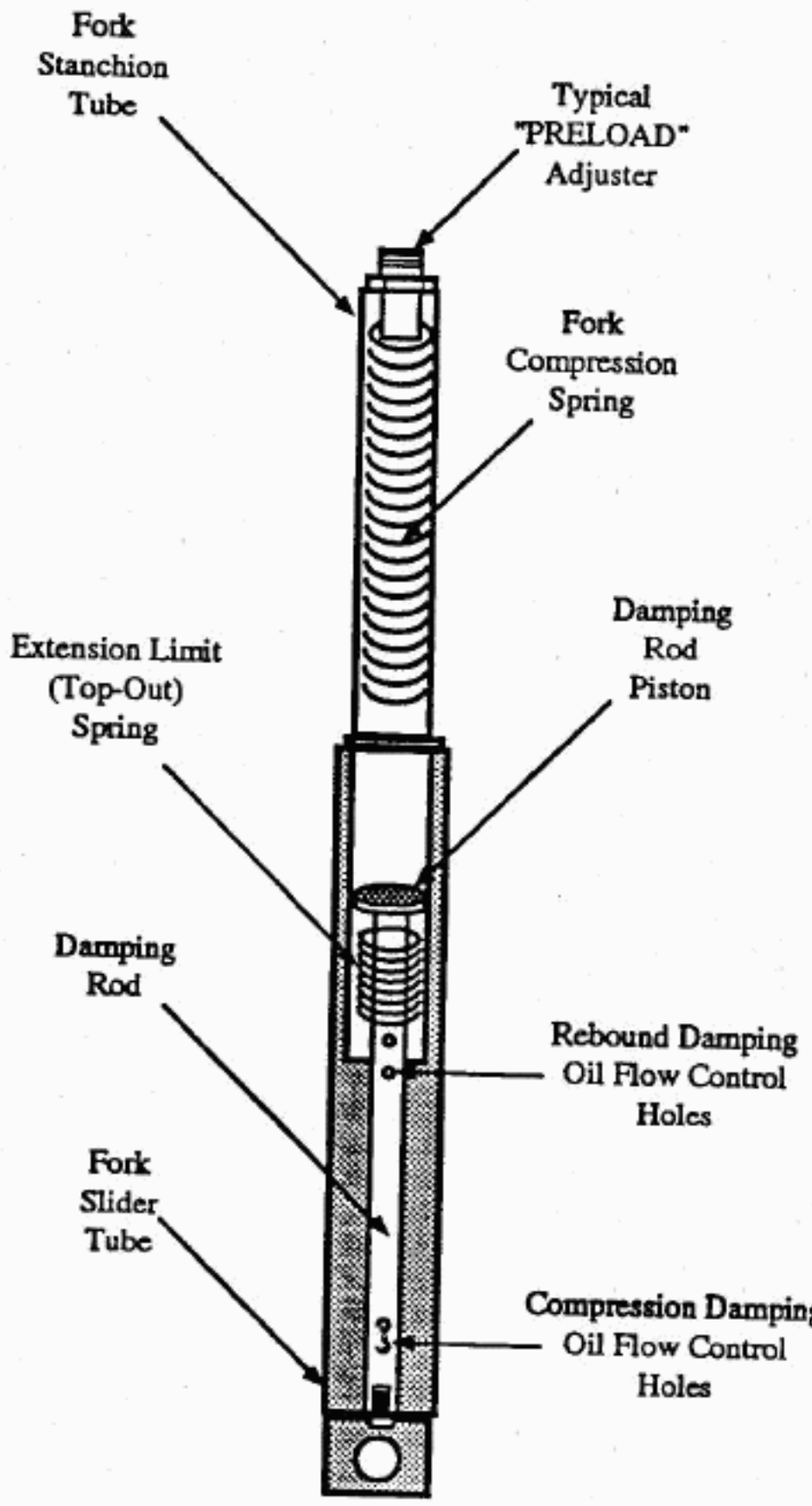
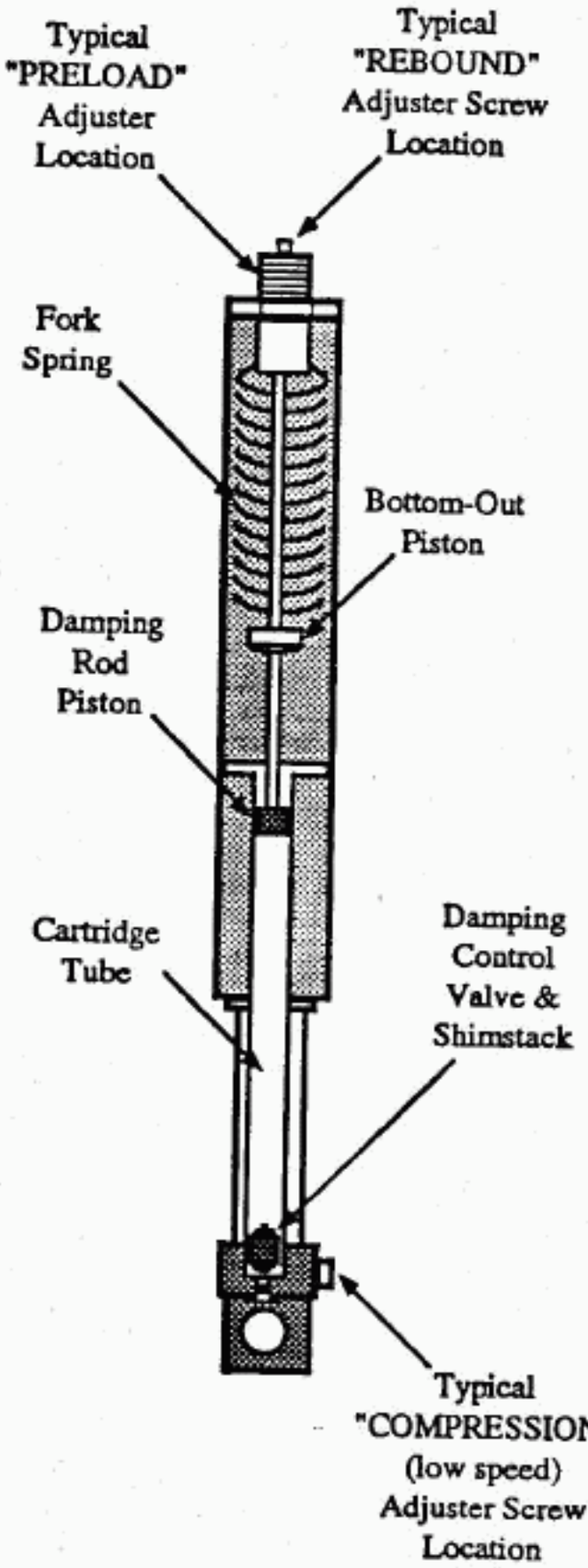
SUSPENSION INTERNALS & ADJUSTMENT LOCATIONS

FRONT FORKS

Typical Damping Rod Style Forks (Old Style)



Typical "Upside Down" Cartridge Forks (New Style)



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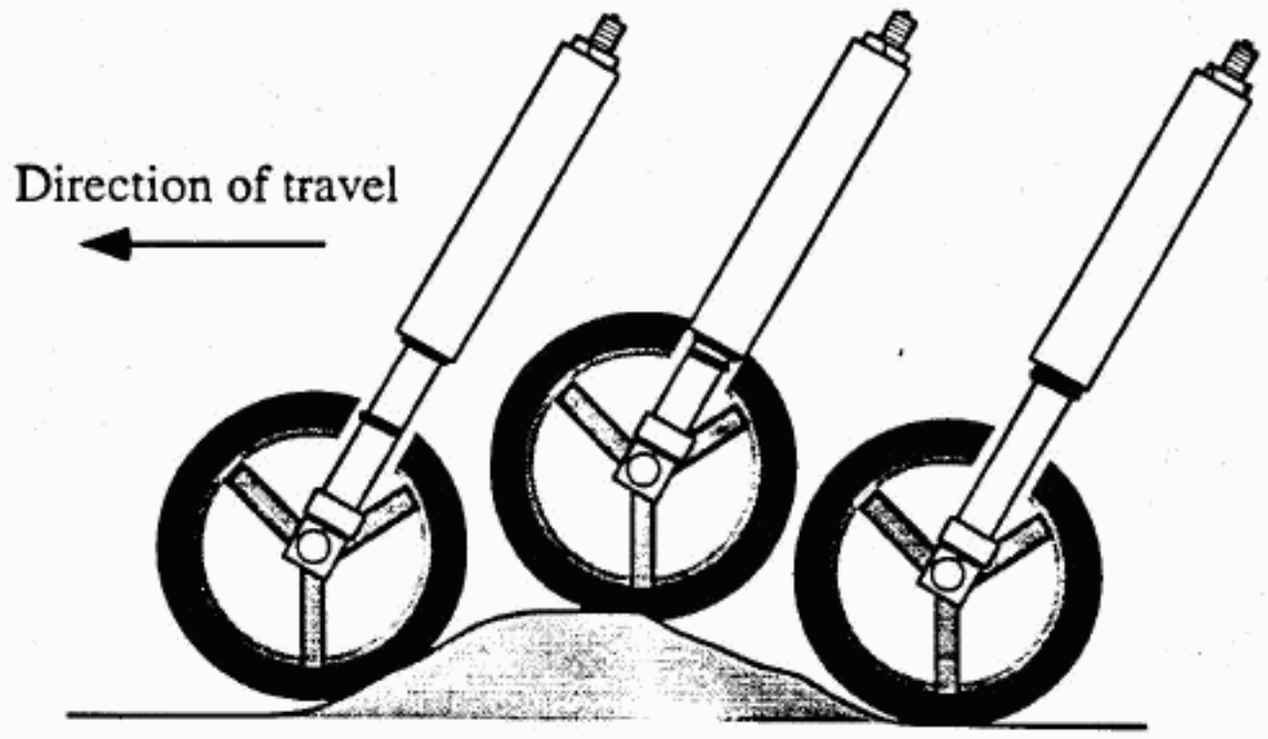
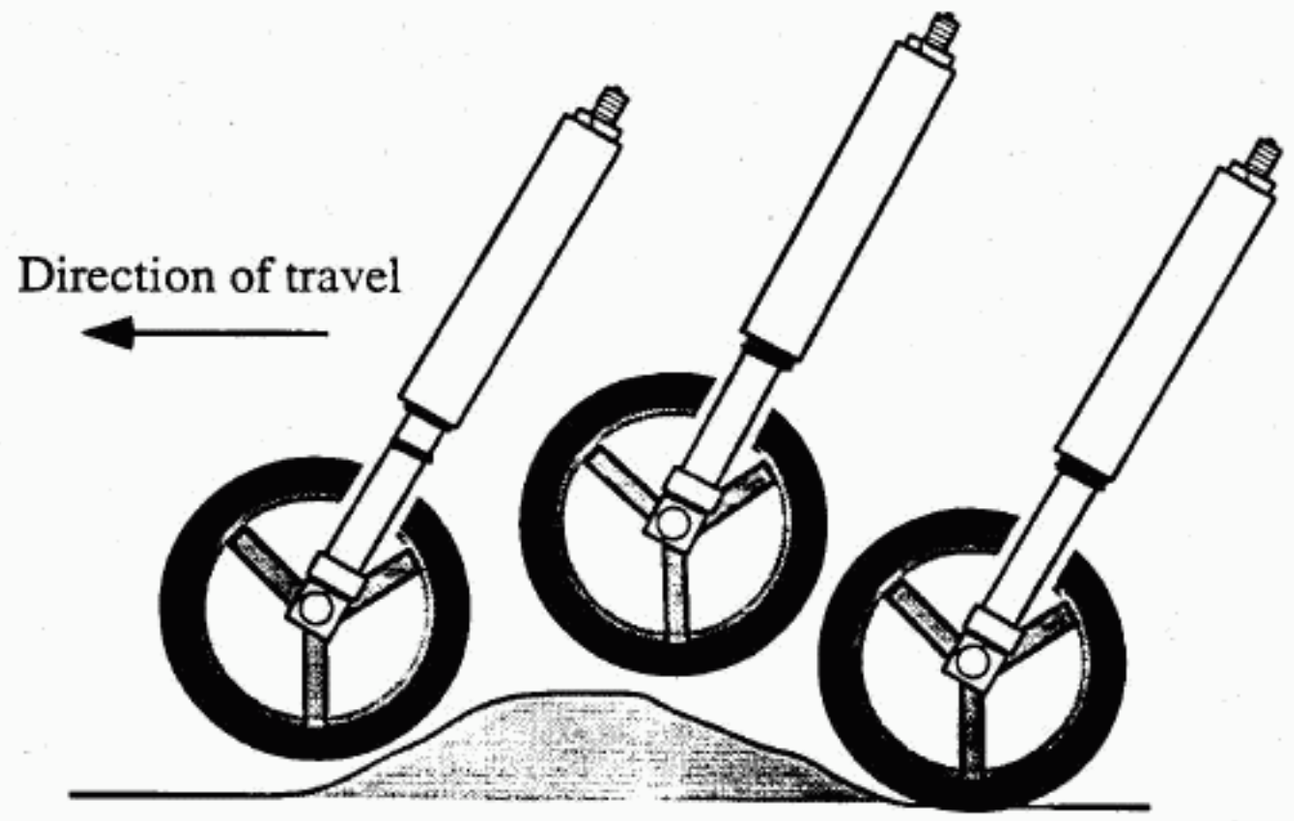
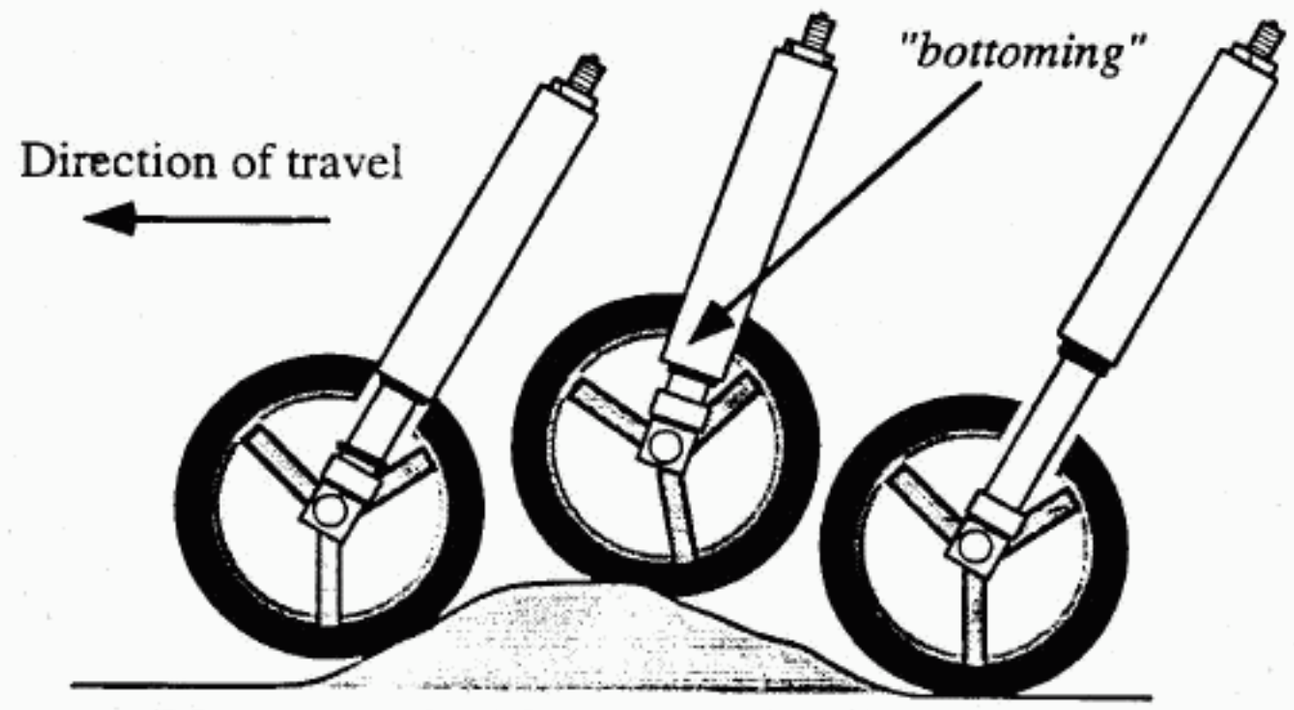
DAMPING SETTINGS: CAUSE & EFFECT
(Compression)



Properly working suspension



Too much "Compression" damping



Not enough "Compression" damping

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DAMPING

Typical Cause & Effects

• COMPRESSION:

FRONT FORKS:

• TOO STIFF: Front end feels "harsh" over bumps, and bike tends to want to run wide upon entering a corner. Front tire may tend appear "skitish" and lose traction in corners, especially when encountering any rough surfaces while at increased lean angles. Front tire may exhibit some insufficiency in obtaining adequate grip while hard braking, due to the lack of proper weight transfer to the front of the bike.

• TOO SOFT: Front end feels "mushy" over bumps, and bike wants to dive excesively under hard braking. The bike may tend to turn into the initial phase of the corner excessively tight, resulting in an "oversteer", yet "wallowy" sensation. Bike may exhibit ground clearance problems while entering corners where the road surface has sharp dips in which sudden suspension loading is experienced.

REAR SHOCK:

• TOO STIFF: Rear end feels "harsh", especially over consecutive bumps. The rider may feel a lack of grip from the rear tire, especially when exiting corners with irregular asphalt surfaces. This lack of rear tire grip will typically be more noticeable, when riding in wet weather conditions, where it will be difficult to "hook-up" upon applying throttle when exiting turns.

• TOO SOFT: Back end feels "mushy" over bumps, and a resulting "wallowing" sensation from the bike's chassis, especially while leaned over at mid corner. Bike may tend to want to run slightly wide ("understeer") at the exit of corners. The bike may also exhibit some nervousness (headshake) from the front end, upon letting off on the throttle on any slightly rough surfaces.

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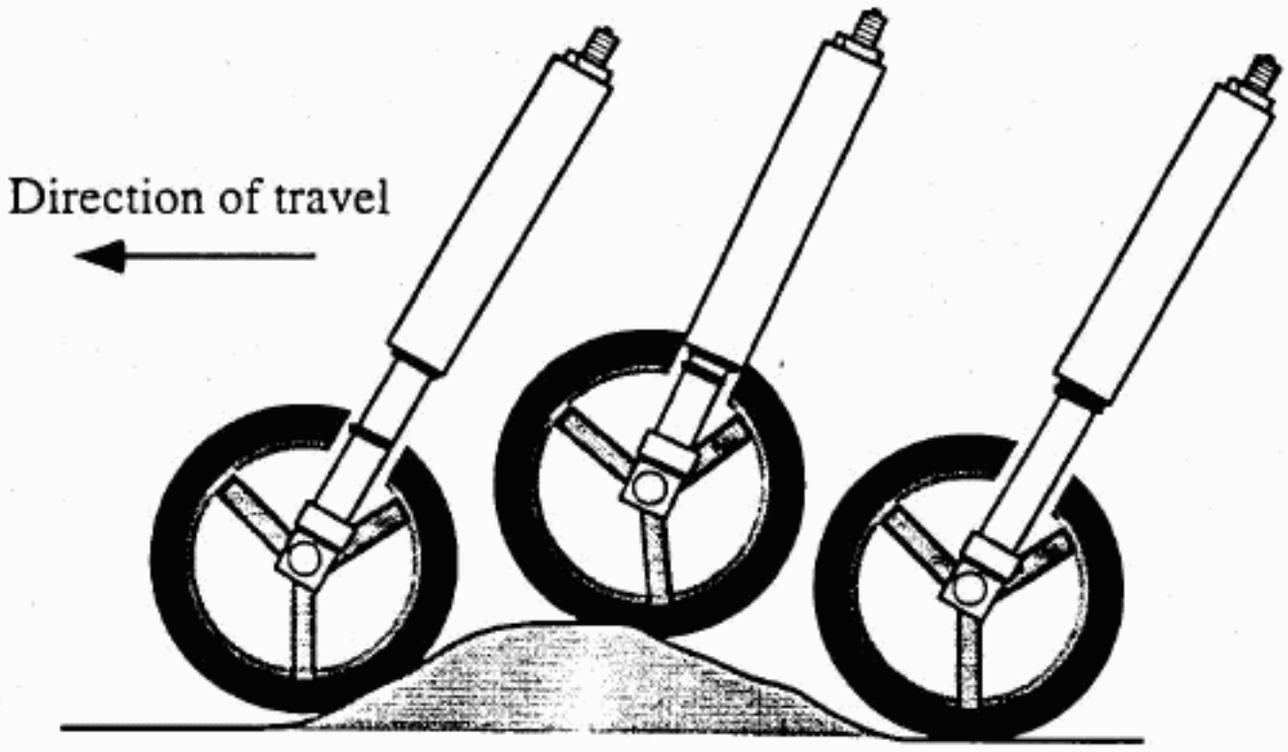
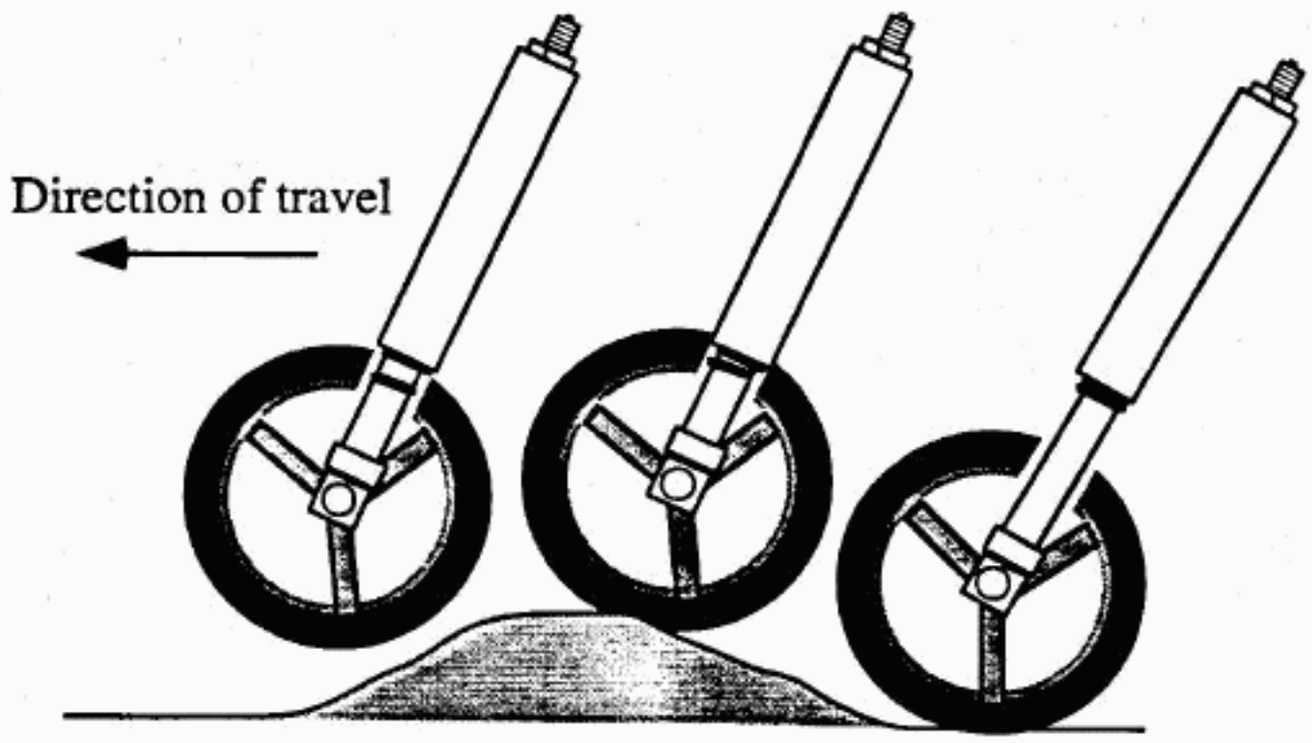
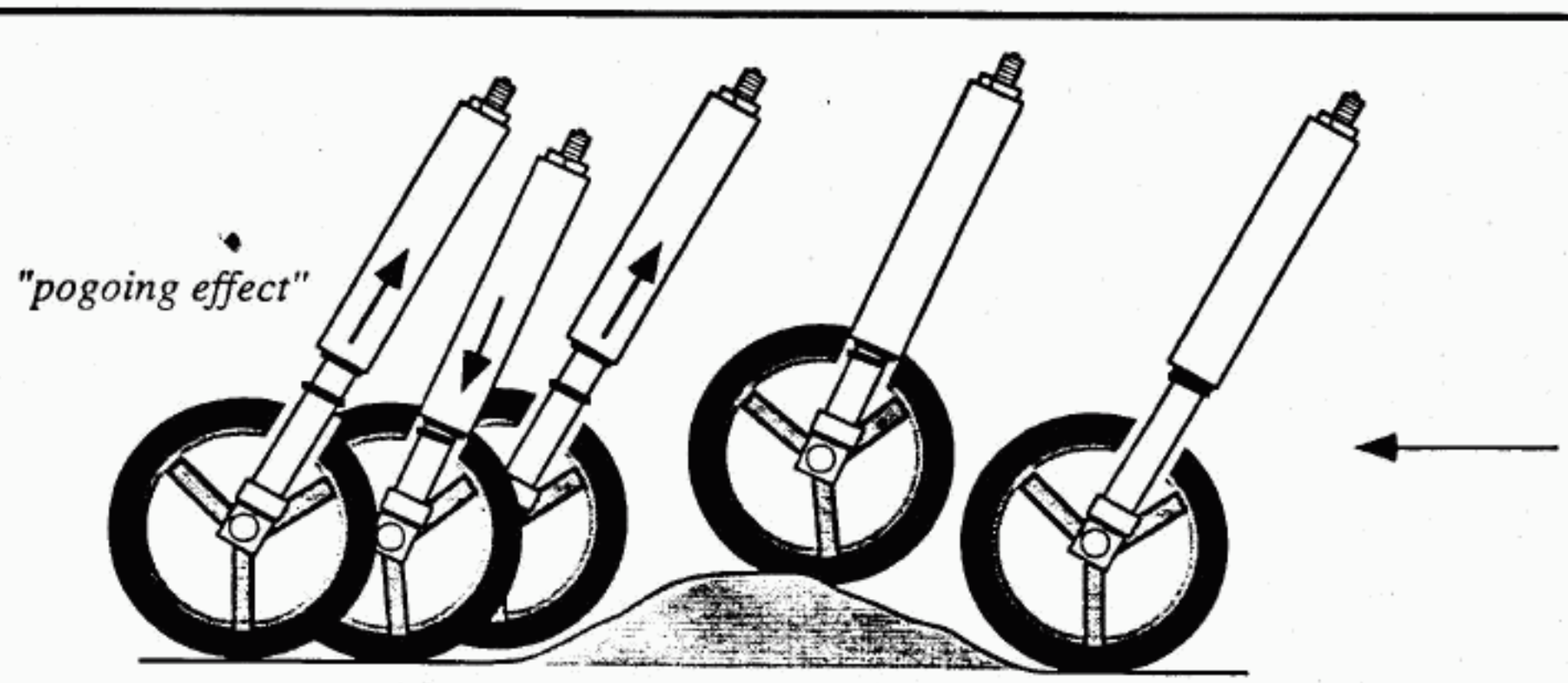
DAMPING SETTINGS: CAUSE & EFFECT
(Rebound)



Properly working suspension



Too much "Rebound" damping



Not enough "Rebound" damping

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DAMPING

Typical Cause & Effects

• REBOUND:

FRONT FORKS:

• TOO STIFF: Front end tends to "Pack Up" over sections of road with closely spaced bumps, resulting in a harsh feeling f the front end (especially upon encountering the last in a series of contiguous bumps). The bike may tend to "oversteer" on entrance to a corner, and want to push the front tire upon leaning the bike into the turn.

• TOO SOFT: General "twitchy" feeling from the front of the bike. The bike will be more prone to throw the rider back on bike, under sudden acceleration, and even result in an increased tendency for more powerful bike's to "wheelie". In corners, the b may have a "wallowy" feeling and want to run wide, especially if there are any rolling impressions in the road surface.

REAR SHOCK:

• TOO STIFF: The bike will have a tendency to try to run wide on the entrance to corners ("understeer"). In addition, a sensati that can be mistakenly diagnosed as a "too stiff shock spring", may be experienced, due to the "Packing Effect" placing the shoc spring in a stiffer portion of it's progressive travel. This is most noticeable on repetitive rolling bumps, that are relatively close spaced.

• TOO SOFT: Back end feels "mushy" over bumps, and a resulting "wallowing" sensation from the bike's chassis, while leane over at mid corner. Upon encountering a sharp edged bump or steep rise at the crest of a road, the rear of the bike will return tc quickly and may even result in the back of the bike (the seat) bounding into the rider's rearend,. The bike may also exhibit som nervousness (headshake) from the front end, upon letting off on the throttle on any slightly rough surfaces.

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"COMPRESSION & REBOUND": ADJUSTMENT PROCESS:

FRONT FORKS:

NOTE: Despite the fact that the adjuster screws may have numerous turns available (mechanically), many suspension's only offer any actual change in damping over a very small range (typically the first turn or so out from maximum CLOCKWISE). On such bikes, 1/4 turn increments offer SIGNIFICANT changes in damping!

• COMPRESSION:

1) Turn "REBOUND" adjuster to MINIMUM (all the way "counter-clockwise")

2) Turn "COMPRESSION" adjuster to MINIMUM (all the way "counter-clockwise")

3) Bounce the front end up and down a few times, by standing the motorcycle upright off it's stand, and holding the front brake on, while pressing on the handlebars, to feel settings.

4) Turn "COMPRESSION" adjuster to MAXIMUM (all the way "clockwise", until LIGHTLY seated)

5) Bounce the front end up and down a few times, using the same process, to feel the difference in this setting.

6) Turn "COMPRESSION" adjuster out in HALF TURN increments (keeping track of how many turns have been applied), and repeat the testing process at each step, until you feel the desired "firmness" provided.

7) Write down on a piece of paper this COMPRESSION setting.

• REBOUND:

1) Turn "COMPRESSION" adjuster back to MINIMUM (all the way "counter-clockwise")

2) Bounce the front end up and down a few times, by holding the front brake on, and pressing on the handlebars, to feel the settings.

3) Turn "REBOUND" adjuster to MAXIMUM (all the way "clockwise", until LIGHTLY seated)

4) Bounce the front end up and down a few times, using the same process, to feel the difference in this setting.

5) Turn "REBOUND" adjuster out in HALF TURN increments (keeping track of how many turns have been applied), and repeat the testing process at each step, until you feel the desired "slowness" in rise of the forks provided.

6) Write down on a piece of paper this REBOUND setting.

7) Turn "COMPRESSION" adjuster BACK to the setting established in the previous steps.

8) Bounce the front end up and down a few times, using the same process, to feel if the combined settings are still in the desired range. (Note there is some interactivity between the two settings, and may require some fine tuning of each)

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REAR SHOCK:

NOTE: Despite the fact that the adjuster screws may have numerous turns available (mechanically), many suspension's only offer any actual change in damping over a very small range (typically the first turn or so out from maximum CLOCKWISE). On such bikes, 1/4 turn increments offer SIGNIFICANT changes in damping!

• COMPRESSION:

1) Turn "REBOUND" adjuster to MINIMUM (all the way "counter-clockwise")

2) Turn "COMPRESSION" adjuster to MINIMUM (all the way "counter-clockwise")

3) Straighten the motorcycle up off it's stand, and while having someone hold the bike stable from the front, push on the back of the bike to bounce the rear suspension up and down a few times, to feel for the settings.

4) Turn "COMPRESSION" adjuster to MAXIMUM (all the way "clockwise", until LIGHTLY seated)

5) Bounce the rear of the bike a few times, using the same process, to feel the difference in this setting.

6) Turn "COMPRESSION" adjuster out in HALF TURN increments (keeping track of how many turns have been applied), and repeat the testing process at each step, until you feel the desired "firmness" provided.

7) Write down on a piece of paper this COMPRESSION setting.

• REBOUND:

1) Turn "COMPRESSION" adjuster back to MINIMUM (all the way "counter-clockwise")

2) Push on the back of the bike to bounce the rear suspension up and down a few times, to feel for the minimum settings again.

3) Turn "REBOUND" adjuster to MAXIMUM (all the way "clockwise", until LIGHTLY seated)

4) Bounce the back end up and down a few times, using the same process, to feel the difference in this setting.

5) Turn "REBOUND" adjuster out in HALF TURN increments (keeping track of how many turns have been applied), and repeat the testing process at each step, until you feel the desired "slowness" in rise of the forks provided.

6) Write down on a piece of paper this REBOUND setting.

7) Turn "COMPRESSION" adjuster BACK to the setting established in the previous steps.

8) Bounce the back end up and down a few times, using the same process, to feel if the combined settings are still in the desired range. (Note there is some interactivity between the two settings, and may require some fine tuning of each)

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• FINAL VERIFICATION:

1) Straighten the motorcycle up off it's stand, and while having someone hold the bike stable from the front, sit on the bike with both your feet on the footpegs.

2) Stand upright on the pegs, and push downward firmly several times, while observing the rate of compression (front vs. rear) of the bike's suspension travel.

3) The ideal balance between front and rear suspension setup (compression, springrate, and weight bias) is achieved when the bike's attitude remains parallel with the ground, during this testing process.

4) IF one end of the motorcycle appears to lag behind the other in it's compressing travel, the compression or spring settings for the forks or shock will need to be changed (either softer or firmer, depending on the desired result) to compensate.

• WET WEATHER RIDING MODIFICATIONS:

The amount of grip available for the tires, when riding in wet weather conditions, is significantly reduced. This reduction in grip, and the resultant decresase in overall speed, reduces the amount of actual suspension "loading" that is tranferred to the forks and rear shock of the bike.

Therefore to optimize the bikes performance (and safety) in these conditions, ALL of the settings that directly effect the "COMPRESSING" side of the suspension's travel, should be "SOFTENED". This softening process consists of the following:

- DECREASING the amount of "COMPRESSION" damping on the forks
- DECREASING the amount of "COMPRESSION" damping for the rear shock
- DECREASING the amount of "PRELOAD" on the fork springs (INCREASING "SAG")

  . INCREASE "SAG" by approximately 6 mm)

- DECREASING the amount of "PRELOAD" on the rear shock spring (INCREASING "SAG")

  . INCREASE "SAG" by approximately 5 mm)

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ADVANCED ADJUSTMENTS

Typical Cause & Effects

• FORK OIL: LEVEL & VISCOSITY:

FRONT FORKS:

• TOO LOW: Front end tends to "Bottom Out" under hard braking. This can be checked by installing a "Zip-Ty" to the inner fork tube, and observing it's resultant position after executing several hard braking stops from a reasonable speed.

• TOO HIGH: The forks exhibit a "solid" feeling (due to "hydraulic lockup") with the front tire often "juddering", under hard braking. The lack of full travel of the "Zip-TY" (mentioned above), will be a result of the existence of this symptom.

• OIL LEVEL ISSUES:

* Optimum method of measurment of proper oil level (distance vs. volume)
* Factors effecting volume of oil required

• VISCOSITY: Thicker oil results in slower fork action (i.e. increased overall damping effect in compression and rebound directions). Thinner oil speeds up fork action, and reduces tendency for fork damping effect to "fade" with extended high speed use.

• WHEELBASE:

REAR WHEEL POSITION:

• FURTHER FORWARD: Bike is a bit more "twitchy" in high speed in straightaways. Bike turns a bit more quickly into corners, and may be more prone to "wheelie" under acceleration, on powerful bikes.

• FURTHER BACK: Bike is more stable in fast straightaways, and a bit more solid feeling during cornering. Bike may require a bit more steering input force, to initiate quick turning manuevers. Reduces the tendency for the bike to "wheelie" under hard acceleration (especially during racetrack style starts).

• RAKE & TRAIL:

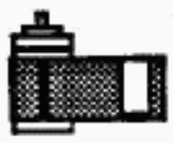
FORK TUBE HEIGHT:

• FORKS HIGHER IN CLAMPS: (MORE tube exposed over top surface of clamp)

[Decreases "RAKE" and "TRAIL", and SHORTENS Wheelbase]

Bike turns into corners more quickly and with less required steering input force on the handlebar. This comes with an increase in the tendency for the bike to be a bit more "twitchy" in high speed in straighaways, especially while exiting bumpy corners with the throttle applied hard. Going too far with this adjustment may result in the bike "oversteering" or wanting to "fall" into corners, as well as exhibiting some instability while leaned over mid-corner in turns. A subsequent reduction in overall ground clearance may present problems with "hardparts" on the bike contacting the asphalt, while leaned over fully in corners. Fender clearance with the radiator or bottom of the lower triple clamp may also be an issue, if this modification is taken TOO far.

• FORKS DROPPED IN CLAMPS: (LESS tube exposed over top surface of clamp)



[Increases "RAKE" and "TRAIL", and LENGTHENS Wheelbase)

Bike is more stable in fast straightaways (due to more of a "self centering" effect), and a bit more neutral feeling during cornering. Bike will require a bit more steering input force, to initiate quick turning manuevers, and may tend to try to run wide ("understeer") in turns. An increase in overall ground clearance will occur, decreasing the chance of the bike dragging "hardparts", at max. lean angle in corners.

PREPARED BY: GARY JAEHNE

COMMON COMPLAINT TROUBLESHOOTING WORKSHEET

COMPLAINT:	POSSIBLE CAUSES:
"Feels too stiff"	1) Too much compression damping 2) Too much spring preload 3) Too thick fork oil 4) Too stiff of a spring, for weight of rider 5) Mechanical binding in linkages due to lack of maintenance
"Runs Wide" Exiting Corners	1) _____ 2) _____ 3) _____ 4) _____ 5) _____
"Bottoms Forks" Under Hard Braking	1) _____ 2) _____ 3) _____ 4) _____ 5) _____
"Wallows in" Corners	1) _____ 2) _____ 3) _____ 4) _____ 5) _____