# FLUID POWER Design Data Sheet-

Womack

*Revised Sheet 8 – Womack Design Data File*

## DESIGN OF CAMS FOR ACTUATING LIMIT SWITCHES

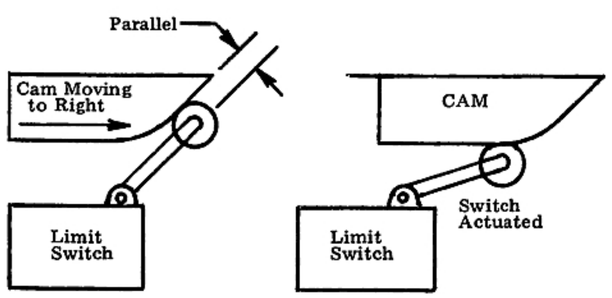


*Figure 1. Cam Angle. Leading Edge of Cam Should be Parallel to Switch Lever Arm.*

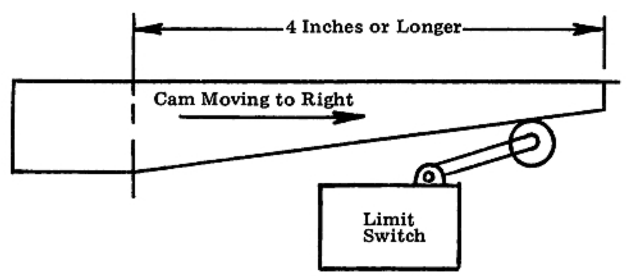


*Figure 2. Cams With Straight Slope on Leading Edge are Suitable for Moderately High Speeds.*

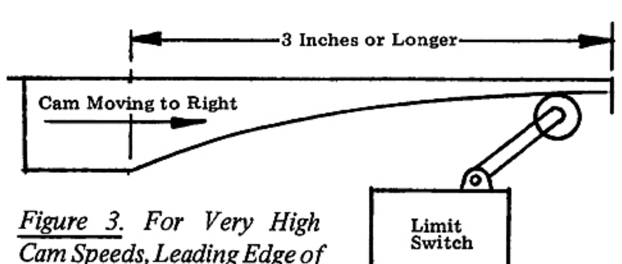


*Figure 3. For Very High Cam Speeds, Leading Edge of Cam Should be Contoured.*

*(Some of the material on switch cams was adapted from information published by R.B.Denison, Inc.)*

Too often there is a lack of attention given to properly actuating a limit switch. The designer may be under the mistaken impression that the size, shape, and contour of the dog or cam which actuates the switch is unimportant, provided it actuates at the right time and has good repetitive accuracy. The facts seem to indicate that the highest percentage of failures in an electrical control system have in the past been due to limit switch failures, and these failures have largely been caused by one or more poor design practices described in this sheet:

1. Many failures have been due to the use, for reasons of economy, of light-duty, non-enclosed, or unprotected switches on applications where heavy duty industrial limit switches should have been used.

2. Improper Cam Angle. Figure 1. The leading edge of the actuating cam should be approximately parallel to the switch arm. Not more than a 15-degree variation should be allowed in either direction.

3. Excessive Rotational Movement. Cams should be designed so they do not over-rotate switch levers. Excess movement results in unnecessary strain on mechanical parts and springs in the switch.

4. Excessive Impact. Sloped or contoured surfaces as in Figures 2 and 3, should be used on fast-traveling cams. High impact on the switch mechanism is a major cause of premature switch failure. At slow cam speeds there is no cause for concern, but at high speed, impact of cam on switch mechanism may cause physical damage to mechanical parts of the switch, but more important, it causes the contacts to bounce, making and breaking the circuit more than once, and during a period of high inrush current. This reduces contact life in proportion to the severity of the bounce.

5. Cam Contour. For cam speeds of 50 feet per minute or less, a fairly abrupt cam approach as in Figure 1 is usually satisfactory. For higher speeds, the cam approach angle should be more gradual as in Figure 2. While this straight slope may give a slight impact to the switch roller, it is satisfactory for speeds up to 200 feet per minute provided the approach angle is very small. The switch should be mounted, at an angle if necessary, so its arm can be adjusted to a position parallel to the slope within ± 15°.

At cam speeds faster than 200 feet per minute, the cam surface should be curved as in Figure 3, to reduce impact on the switch mechanism at the moment of contact, and to give a smooth acceleration to the switch arm. Length of contour should be at least 3 inches, longer if possible. As in all cam designs, the switch should be mounted so its lever can be adjusted to be as nearly parallel to the cam surface as possible.

At cam speeds over 400 feet per minute, it is especially important to have as long a contoured cam surface as space permits – at least 6 inches or longer.



6. Overriding Cams. Figure 4. On those applications where a cam must travel past a limit switch, the switch arm should never be allowed to drop abruptly off the cam surface. This "fly-back" will produce severe strains on mechanical parts and springs in the switch, and will greatly shorten switch life by causing multiple pulsing of the contacts.

The trailing edge of an overriding cam should be sloped or contoured to prevent rapid "fly-back" of the lever. While not as critical as slope of the leading edge, the angle between trailing edge and switch lever should be no greater than 30°. Remember, too, that the cam must pass back over the switch arm on its return stroke unless a 1-way actuator is used.

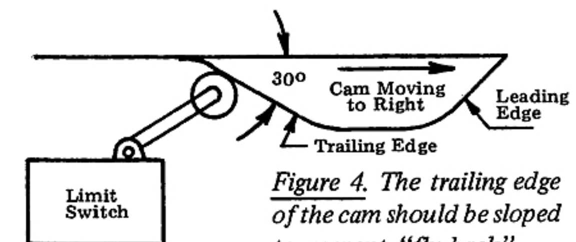


*Figure 4. The trailing edge of the cam should be sloped to prevent "fly-back".*

Return speed of the cam should be considered in designing the slope angle of the trailing edge.

7. Excessive Current. Handling an excessive amount of current will reduce contact life. Inrush current to a hydraulic valve solenoid coil may be 4 or 5 times its normal holding current after the solenoid armature has seated. Rather than handle excessive inrush current, the switch may energize the coil of an industrial relay or contactor rated to handle the high solenoid inrush current.

## NOTES ON THE PLACEMENT OF LIMIT SWITCHES

Figure 5. Sustained Signal. While in most applications a limit switch is placed to actuate very close to the end of a cylinder stroke, there are cases where a switching signal is needed at some intermediate point in the stroke of a cylinder. If the switching signal then must be maintained during the remainder of the stroke, an extended cam attached to a moving member of the machine will keep the switch actuated.

Note: As a safety precaution, the long cam may be used on any application where there is a possibility of the cylinder accidentally overriding the switch. A short cam might get behind the switch lever and damage it on the return.

Figure 6. Momentary Impulse. If a momentary switching signal must be produced at some point in a cylinder stroke, a limit switch with 1-way roller actuator may be used. The "knee-action" of the switch arm causes the switch contacts to actuate as the cam on the cylinder moves outward. On the return stroke, the switch lever folds down without actuating the switch contacts. If the switch is turned to face the other direction, the switching impulse occurs on the return stroke of the cylinder.

The same 1-way action is produced with a half-roller actuator which actuates the switch contacts in one direction of motion, and rotates out of the way of the actuating cam in the other direction of motion.

Figure 7. Impulse Switch. The impulse type limit switch provides a means of generating a switching signal only during the last one-half inch of cylinder stroke. It must be protected by a positive stop to limit cylinder travel. When the cylinder reaches the positive stop, the switching signal is cut off. On the start of the cylinder return stroke, the switch plunger springs back out without generating another switching signal. This switch is useful in circuitry where the cylinder, at the end of its forward stroke, must "stand" on a limit switch, and the maintained signal thus generated would be difficult to override later in the cycle.

Figure 8. A plunger-type limit switch may be used in circuits which require high sensitivity or great accuracy and repeatability in switch actuation. The switch is mounted for head-on actuation, but must be backed up with a positive stop to prevent damage if the cylinder should accidentally try to override the switch due to a control circuit failure.

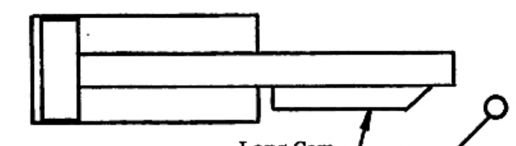


*Figure 5. Sustained Signal*

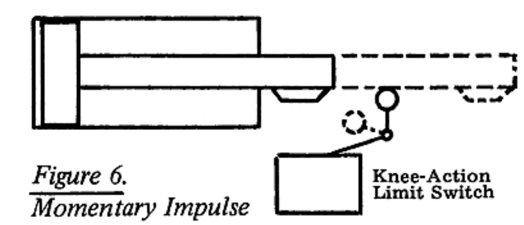


*Figure 6. Momentary Impulse*

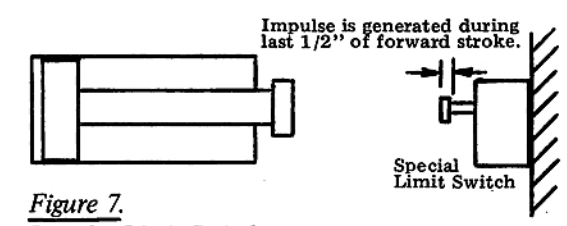


*Figure 7. Impulse Limit Switch*

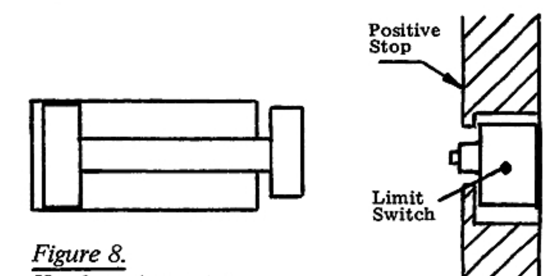


*Figure 8. Head-on Actuation*


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**WOMACK EDUCATIONAL PUBLICATIONS**
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