



LIMIT STOP SERVOCONTROL SYSTEM

This application is a continuation of application Ser. No. 794,625 filed Jan. 28, 1969, now abandoned.

BACKGROUND OF THE INVENTION**1. Field of Invention**

This invention relates to servo loop control systems, and more particularly to a unidirectional servo limiter.

2. Description of the Prior Art

In many servo loops known in the prior art, a position reference signal may be applied which calls for a position that is past a mechanical stop or other physical limitation on the position of the servoed device. If this occurs, the servomotor will remain operative, driving the device against the stop. This will cause it to dissipate full stall power for as long as the condition remains. In many instances, especially with high power servomotors, this may result in excessive overheating which in turn detrimentally affects the reliability and overall life of the motor. In order to overcome this, some devices known to the art have provided servo gain limitations whenever positions are sensed near a stop. However, such limitations are operative when driving away from the stop as well as when driving into the stop. Thus, there is a significant loss in response speed of the system as a result of stop limitations.

SUMMARY OF INVENTION

An object of the present invention is to provide an effective limit to the position reference signal to a point very close to a stop in a servosystem, with a tight tolerance under a wide variety of power supply and temperature conditions, and with no loss in performance.

According to the present invention, a feedback circuit is provided in a servoamplifier, the circuit being effective to substantially clamp the output of the amplifier to a voltage corresponding to a given position reference voltage in response to a potential indicative of approaching a stop. The feedback circuit is operative only in response to amplifier output potentials of a polarity tending to drive the servoed device toward the stop, and is inoperative in response to potentials tending to drive the servoed device away from the stop.

The present invention provides a relatively cheap and reliable capability for servo limiting in the area of the stop, without loss of system response characteristics when driving away from a stop. The device is reasonably accurate under a wide variety of temperatures and power supply variations, and may be implemented in simple technology.

BRIEF DESCRIPTION OF THE DRAWING

The sole FIGURE herein is a schematic block diagram of a preferred embodiment of the invention, implemented to operate in two polarities.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the figure, in a preferred embodiment, a servoed device 10 is driven by an AC motor 12 which responds to a modulator 14 in dependence upon a DC potential applied thereto by an amplifier 16. The amplifier in turn responds to signals provided by a feedback resistor 18, an input control signal through a resistor 20, and a position feedback signal through a resistor 22, all of which are joined at a summing point 24 and applied to a negative input 26 of the amplifier 16. In response to a negative signal at the input 26, a positive signal is provided at an output 28 of the amplifier 16. For exemplary purposes herein, it is assumed that the positive signal at the output 28 will cause the AC motor 12 to drive the servoed device 10 toward a given stop. This given stop is assumed to be in a direction equivalent to the top (most positive end) of a feedback potentiometer 30, the wiper of which is connected to resistor 22 so as to provide actual position information into the servo loop. This is mechanically driven by the servoed device 10. The resistor 20 is connected to a position reference voltage control 32 which may be, for instance, an

operator controlled device that indicates the desired position of the servoed device 10 by providing a suitable potential, such as may simply be achieved by means of a voltage source and a potentiometer. The feedback loop including the resistor 18 incorporates a demodulator 34 to convert an alternating-current potential to a direct current potential for feedback input to the amplifier 16.

The system described thus far conforms to a typical type of servosystem known to the prior art. A description of the servo limiting in accordance with the present invention follows.

For exemplary purposes, consider the situation when the servoed device is driving toward the top of the potentiometer 30, and will reach a stop when the wiper of the potentiometer 30 nears the most positive end thereof. The circuitry now to be described is used to limit the operation of the servosystem as the servoed device approaches that stop. The wiper of the potentiometer 30 is connected to a resistor 36, through another potentiometer 38 and a resistor 40 to a negative supply. Thus, there is a voltage divider from the positive source through the feedback potentiometer 30, and the resistances 36, 38 and 40. The base of an NPN-transistor 42 is connected to the wiper of the potentiometer 38, which wiper may be adjusted in order to adjust the point of operation of the transistor 42 in comparison with the position of the wiper on the potentiometer 30, and the actual voltage and resistance values used in the system. The emitter 44 of the transistor 42 is connected to the summing point 24, and the collector 46 of the transistor 42 is connected through a diode 48 to the output 28 of the amplifier 16. The diode 48 is poled to be conductive when the output of the amplifier 16 is positive. Thus the transistor 42 can in turn operate with gain only during positive outputs of the amplifier 16. Assuming that the resistances 36, 38 and 40, and the adjustment of the wiper of the potentiometer 38, are all selected so as to give proper operation, when the wiper of the potentiometer 30 reaches a given point near the stop when limiting action is desired, the transistor 42 will conduct thus connecting the output of the amplifier 16 at point 28 to the summing network 24 at the input 26 of the amplifier 16. This effectively clamps the amplifier at that potential, and prevents any further driving of the servoed device. Thus, the device is electrically limited before reaching its mechanical stop, and driving against the stop is avoided.

Now consider the case where the servoed device 10 is driven toward a stop which is equivalent to the most negative part of the potentiometer 30. To provide servo limiting in this direction, the resistor 36 is also connected through a potentiometer 50 and a resistor 52 to a positive source. The wiper of the potentiometer 50 is connected to the base of a PNP transistor 54, the emitter 56 of which is connected to the summing junction 24. The collector 58 of the transistor 54 is connected through a diode 60 to the output 28 of the amplifier 16. Only when the output of the amplifier 16 is negative will the diode 60 conduct, and therefore the transistor 54 will be operative to clamp the amplifier 16 only in the case where the most negative end of the potentiometer 30 is reached in response to a negative output signal.

Note that in the first instance, when the servoed device is driving toward the most positive portion of the feedback potentiometer 30, in the event that the position reference voltage control 32 is readjusted so as to provide a positive voltage and tend to drive the servoed device 10 towards a position which corresponds to the most negative position of the wiper on the feedback potentiometer 30, then the output of the amplifier 16 becomes negative so diode 48 no longer conducts and the limiting action of feedback through transistor 42 does not affect driving the servoed device away from the stop. On the other hand, as soon as the negative output from amplifier 16 causes diode 48 to be reversed biased, the diode 60 is forwardly biased. But since the feedback potentiometer 30 has been set near the positive end, transistor 54 does not conduct so there is no limiting action in this case unless the device is driven all the way toward the negative end of the feedback potentiometer 30.

Notice that the transistors 42, 54 are controlled directly by potentials developed by the feedback potentiometer, and therefore errors in operating the clamping of the servosystem in accordance with the present invention are minimized. Similarly, regardless of minor differences in the power supply potentials which may occur and of resistance variations as a result of temperature changes, the direct operation by utilizing a clamping feedback loop which is directly controlled by the feedback potentiometer provide relatively accurate operation.

Although the invention has been shown and described with respect to a preferred embodiment thereof, it should be understood by those skilled in the art that various changes and omissions in the form and detail thereof may be made therein without departing from the spirit and the scope of the invention.

Having thus described a typical embodiment of my invention, that which I claim as new and desire to secure by Letters Patent of the United States is:

1. A servoamplifier system adapted to drive a servoed device toward and away from at least one limit stop in response to a desired position reference input signal and an actual position feedback signal indicative of the position of the servoed device, said system adapted to limit the output signal of an amplifier in the amplifier system as the servoed device approaches the stop, yet not limit the output signal of the amplifier when driving the servoed device away from the stop, said system comprising:

- an amplifier circuit having an input and an output out of phase with said input;
- a summing network connected to said input;
- a servoed device driven in response to the output signal of said amplifier circuit and having at least one position limit stop;
- means connected to said summing network for providing a desired position reference signal thereto;
- position feedback signal means controlled by said servoed device to develop an actual position feedback signal indicative of the actual position of said servoed device;
- means responsive to said position feedback signal means and connected to said summing network for coupling said actual position feedback signal thereto;
- limit means responsive to said position feedback signal

means for developing a limit stop signal indicative of the relative position of said servoed device with respect to said limit stop;

and limit stop feedback means connected directly between said output and said summing network, said limit stop feedback means having an operative state and a nonoperative state, said limit stop feedback means when in its operative state providing unilateral conduction between said amplifier circuit output and said input summing network, thereby to clamp said amplifier circuit with negative feedback, said limit stop feedback means poled so as to conduct output signals from said output to said summing network only of a polarity tending to drive said servoed device toward said limit stop, and not of a polarity tending to drive said servoed device away from said limit stop, said limit stop feedback means connected to said limit means and rendered operative by a limit stop signal of a given magnitude.

2. The servoamplifier system according to claim 1 wherein said servoed device has a second limit stop, and additionally comprising:

- second limit means responsive to said position feedback signal means for developing a second limit stop signal indicative of the relative position of said servoed device with respect to said second limit stop;
- and second limit stop feedback means connected directly between said output and said summing network, said second limit stop feedback means having an operative state and a nonoperative state, said second limit stop feedback means, when in its operative state providing unilateral conduction between said amplifier circuit output and said input summing network, thereby to clamp said amplifier circuit with negative feedback, said second limit stop feedback means poled so as to conduct output signals from said output to said summing network only of a polarity tending to drive said servoed device toward said second limit stop, and not of a polarity tending to drive said servoed device away from said second limit stop, said second limit stop feedback means connected to said second limit means and rendered operative by a second limit stop signal of a given magnitude.

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