The Exciting Renaissance of

PULSE PROPORTIONAL

Modern Sophistication and Reliability Keynote the Rebirth of An Old Favorite As It Sweeps To An All-time High In Popularity.

A full-house multi? Not at all – Bob Schneider's 50", .19 powered high-performance design for Galloping Ghost.

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KEN WILLARD:

As I promised you last month, I'm going to take a stab at explaining the radio control system known as Galloping Ghost. It won't be easy, because the doggone system is so simple it's hard to explain what all the flopping is about! Also, a lot of other guys have explained it, yet from the letters I keep getting, your reaction has been "Wha'd he say?" Maybe you'll still feel the same after you read this. Well, let me tell you something; I understand the aerodynamics involved, and the mechanical linkages on such units as the Rand, Tomoser, World Engines, or the "birdcages" that are used with a simple actuator — but I'm still hazy when it comes to electronic decoders, tone detectors, pulse omission or pulse rate detectors, that are used on some of the more sophisticated systems. However, the net result is the same — proportional control at a very reasonable cost.

Most of you, by now, know where the term "galloping ghost" comes from. Briefly, though, for some of you newcomers, the term describes the flight path that models used to take. I say "used to take" because the term really isn't descriptive any more. But in the early days, the control system used to make the rudder flop slowly from right to left, with the elevator simultaneously flopping almost full up to full down. This caused the tail of the model to

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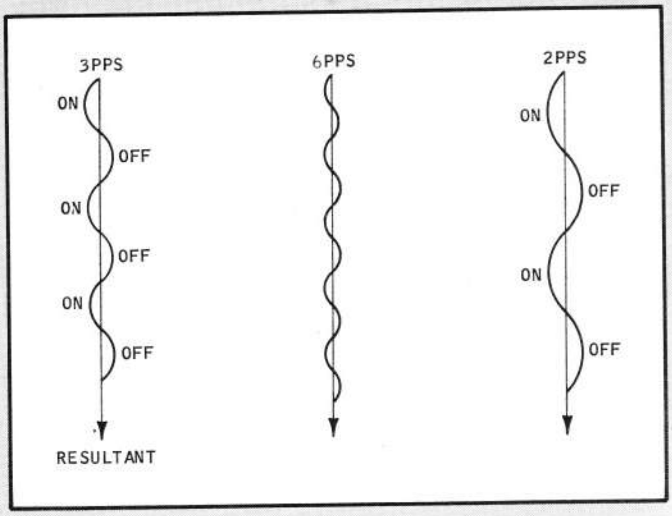
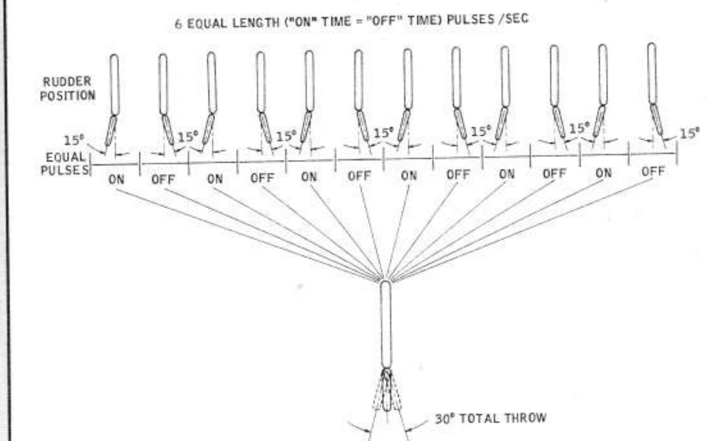
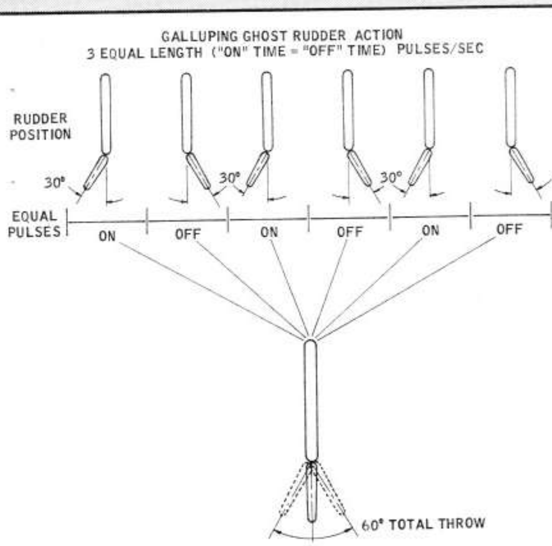




NET RESULT - NEUTRAL RUDDER
FIG. 2



NET RESULT - NEUTRAL RUDDER
FIG. 1

Ken Willard explains the "Basics" of Galloping Ghost. Now more popular than ever before, this was one of the earliest forms of proportional control. Once considered as "Mickey Mouse," or a "Tinkerer's Delight," single channel proportional has come of age, due largely to the perseverance of its devotees and the efforts of a few manufacturers to perfect this phase of R/C.

oscillate up and down and right to left as the model flew through the air; it seemed to be galloping along, and since the control was invisible, it got the name "galloping ghost."

O.K. Now, just what is this system? How does it operate?

Well, it begins at the transmitter. The simplest transmitters, now available, when turned on, send out a continuous "carrier wave" on the frequency which has been "tuned in" to the circuitry of the transmitter through the "crystal." Then, when another part of the circuit is actuated by closing a switch, or pushing a button (which is really a switch), this causes a "tone" signal to go out over the carrier wave. This tone signal, when received by the receiver (which has been tuned to match the carrier frequency of the transmitter) causes a circuit in the receiver to close. When this happens, the battery supply in the circuit, which has been closed by the tone signal, in turn sends voltage to an actuator — which may be an escapement, a motorized servo mechanism, or a magnetic device, depending on the modeler's choice.

In the case of the escapement the operation is obvious. When a tone signal is sent by the transmitter, the receiver circuit to the escapement is closed, sending voltage to the coil of the escapement. The magnetic force which is generated "pulls in" the armature, or "rocker" on the escapement, permitting the mechanism to turn to the first stop. This movement, by a series of linkages, causes the rudder to move (or whatever surface or other device is connected to the escapment). Then, when the tone signal from the transmitter is discontinued, the escapement circuit in the receiver is opened, voltage to the escapement is cut off, and the spring on the armature pulls it back to the open position, permitting the escapement to proceed to the next position — or back to a neutral position, depending on the geometry of the escapement mechanism.

I know we're not discusing escapements, but this little background helps lead into the galloping ghost type of control. You see, with the escapement method of control, the airplane, when not receiving a signal, is basically in free flight mode. This fact, at one time, caused a writer to describe single channel radio control as "free flight, periodically disturbed by a radio command." This resulted in a lot of irate letters from avid single channel enthusiasts. Well, the furor died down, as modelers recognized the basic truth. What wasn't said is that a skillful man at the control of the transmitter can "disturb" the flight of an escapement controlled model in such a way as to make it perform many of the aerobatic maneuvers!

Now when you progress to galloping ghost, there's a difference. The model is never in free flight mode. It is continuously under control from the transmitter. Please don't nit pick the "on-off" bit, because the surfaces are continually moving from one position to the other, so it is continuous. Changes to the airplane design can be made to take advantage of this — less dihedral, for example, making inverted flight easier to

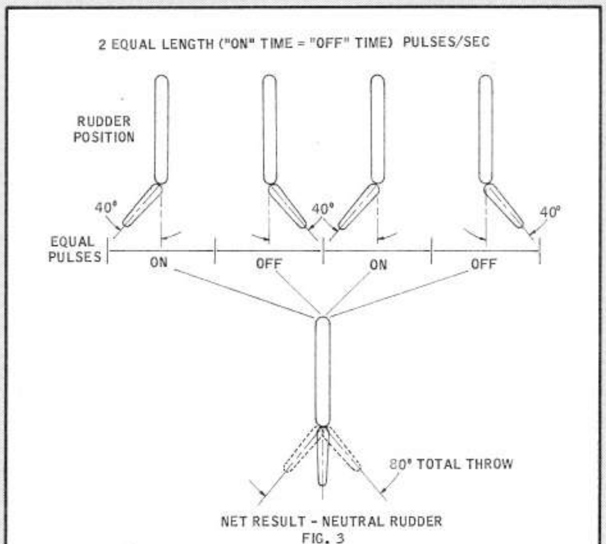


FIG. 3

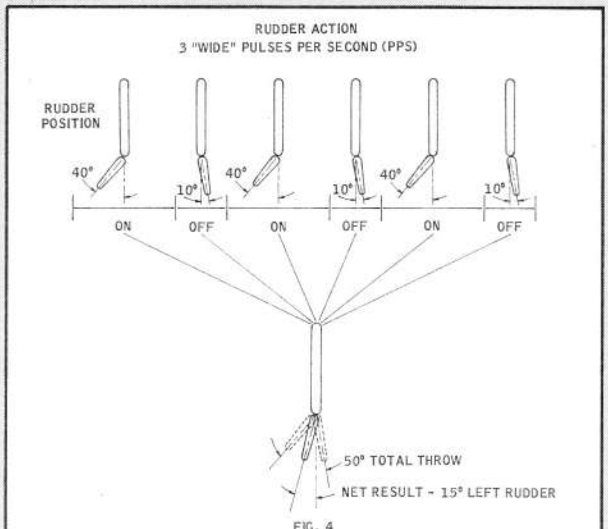


FIG. 4

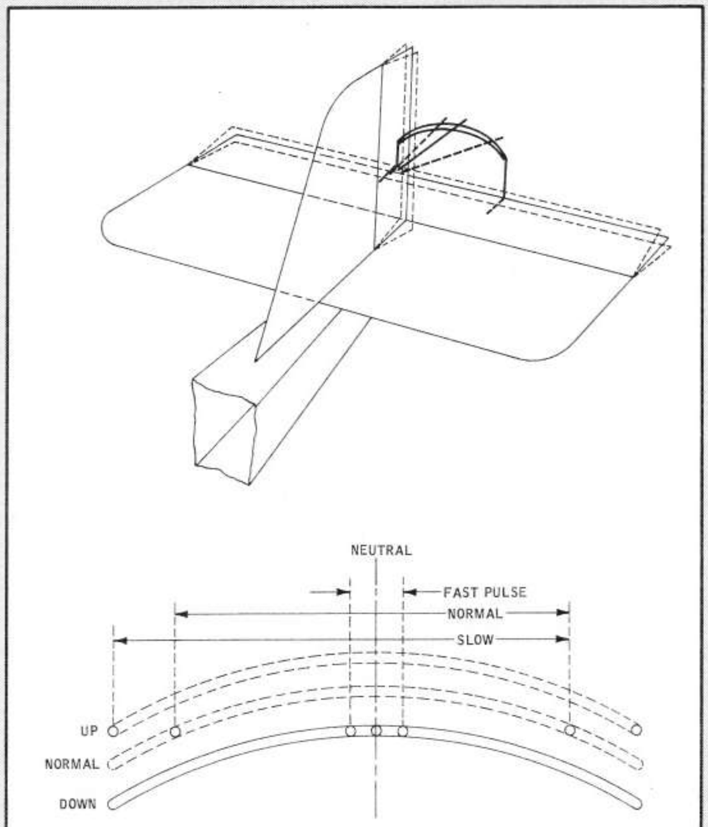


FIG. 5

Galloping Ghost, simply stated, is utilizing a single tone from a transmitter in such a fashion as to provide information to operate rudder, elevator, and motor from one mechanical actuator.

maintain.

So let's get into the meat of this on-off sequencing of the tone signal from a single channel transmitter which comes out as galloping ghost.

First, there's the "pulser." Actually, it's nothing but a mechanical or electronic button pusher which establishes the length of time the transmitter sends out a tone in comparison to the length of time the signal is off, and also establishes the rapidity with which the total on-off sequence is completed.

The relative length of time the signal is "on" compared to the length of time the signal is "off" is called "pulse width."

The rapidity with which the on-off sequence is completed is called the "pulse rate."

O.K. Now let's go to the receiver. To handle the pulses, the receiver circuit to the actuator is a little different. It's set up so that when the receiver is turned on, a circuit to the actuator is also turned on, even though no signal is being transmitted to the receiver. The voltage thus going to the actuator makes it start to run in one direction, if it's motor driven, or move in one direction if it's magnetically operated. Then, when the transmitter sends a signal, the receiver shuts off the "no signal" circuit to the actuator, and turns on a "signal on" circuit. This latter circuit reverses the direction of the current flowing through the actuator and makes it move, or run, in the opposite direction.

The receiver accomplishes this reversal of current to the actuator in several ways, depending on the receiver design. Most common, of course, is the relay method, where opening and closing the relay does the job. Relayless receivers have a power transistor which allows current to flow under a "no signal" condition, but which is cut off, and another transistor cut in when a signal is received. There are other devices, but we're not concerned with them right now. What we want to get at is the net result of all this on-off, pulse width, pulse rate action.

Let's look at what can be done with the condition where, during a one second interval, 3 "on" pulses are sent, and each pulse is $\frac{1}{6}$ of a second in length, followed by an "off" period of $\frac{1}{6}$ of a second. Figure 1 shows that the actuator will drive the rudder, through the linkages, alternately right and left, and an equal amount in each case.

Now look at Figure 2. Here the number of pulses per second (PPS) has been increased to six, but the relative length of "on" time to "off" time has been kept equal — in this case $\frac{1}{12}$ second on, $\frac{1}{12}$ second off. Again, the actuator drives the rudder alternately right and left, in an equal amount, but not so far, because the actuator doesn't have time to run in one direction very far before the current is reversed and it starts to go back.

Fig. 3 shows what happens when you reduce the number of pulses per second (PPS) to 2, but maintain equal "on" and "off" time intervals, in this case $\frac{1}{4}$ second on, $\frac{1}{4}$ second off.

So neutral rudder action results, as stated on the summary, if the "on" pulse

(Continued on Page 65)

KEN WILLARD

(Continued from Page 25)

is equal to the "off" period in elapsed time.

However, even though the net result is neutral rudder, which would give straight flight if the airplane is properly trimmed, the flight path would oscillate slightly.

Obviously, the faster the pulse rate, the less deviation from neutral, and less "gallop" to right and left. In actual practice, a pulse rate of 6 PPS results in a flight path without visible oscillation for most models.

Now let's take a look at what happens with the rudder action when we vary the relative length of time the "on" signal is transmitted compared to the "off" period immediately following in any given unit of time. If the "on" pulse is longer than the "off" time, the actuator will run further in the direction caused by the current resulting from the "on" signal circuit, before the current

(Continued on Page 66)

KEN WILLARD

(Continued from Page 65)

is reversed when the signal is "off." And before the actuator can complete its return movement, the "on" signal drives it back. Confusing? I guess so, when you say it fast — but not when you see it. So Fig. 4 is a somewhat exaggerated diagram which should clear it up. I hope.

And that sums up the situation insofar as galloping ghost operation of the rudder is concerned.

Now to tackle the elevator movement. Since, as we have seen, the rudder action is independent of the pulse rate, then we need to figure a way of translating pulse rate into elevator movement.

Fig. 5 shows an ultra simple installation back at the elevator which will do just that. A wire, sticking straight out from the rudder trailing edge, in line with the rudder, passes through an arc slot made of wire and attached to the elevator as shown.

When the rudder is in neutral, the wire from the rudder passes through the arc of the slot at the uppermost point.

When the rudder is in full right or full left, the wire passes through the slotted arc at the extreme right or left ends, both of which are lowermost on the arc. And when this happens, since the wire moves horizontally as the rudder swings, the slotted arc must move up whenever the rudder moves away from neutral. This pulls the elevator up.

So now we have a condition where, with neutral rudder, the elevator is full down; and with full right or left rudder, the elevator is full up. Just what we want in order to take advantage of "pulse rate."

With a fast pulse rate, the actuator — and in turn the rudder — doesn't move very far in either direction. This keep the wire near the top of the arc. So, with **fast** pulse rate, we get **down** elevator.

With slow pulse rate, the rudder will oscillate from right to left, the wire will move from end to end in the slotted arc, and the elevator will flop **all** the way down. The average, or mean, position of the elevator under this condition is the effective full up position. So, with slow pulse rate, we get **up** elevator.

With a pulse rate somewhere in between the fastest and the slowest, the rudder will oscillate part way to right and left, and the elevator will flop **part** way up and all the way down. Thus a median, or **average pulse rate** can be established which will yield a **neutral** elevator.

And that's all there is to it — unless you want to go into all of the infinite number of variations in combinations of pulse rate and pulse width. There's not enough time or space for that — but let's just look at a couple. For example, if you have an on-off switch on your transmitter in addition to a pulser (most commercial setups do) and you're using a simple setup similar to Fig. 5, you can get some very spectacular flight maneuvers by either turning the transmitter full on or full off. Either condition will result in full up elevator (even more than when pulsing since the wire remains at the end of the arc) and full right or left rudder. And this is where the controls should be to do snap rolls or spins.

After you become familiar with some of the interactions, it will become apparent that, as pulse width is varied to get rudder action, there is some interaction with the elevator linkage which tends to give a little up elevator action at the same time. Normally this is fa-

(Continued on Page 68)

KEN WILLARD

(Continued from Page 66)

vorable, since most models tend to drop the nose in a turn. However, if the interaction is too pronounced, and the nose tends to come up in a turn, you can apply any needed correction by increasing the pulse rate at the same time as you vary the pulse width.

Back to the on-off switch plus pulser combination. In the simple setup, you can use it for aerobatics — but the gadgeteers, like Herb Abrams, Herb Tomoser (must be related somehow to the Chinese herbs, the way they keep sprouting ideas) and all the others, have devised various ways of letting motorized actuators run continuously in either direction, depending on whether signal is "on" or "off" and while the rudder and elevator are flopping merrily right and left, up and down, a linkage to the motor moves forward or back and gives engine control.

Of course, there are the electronic counterparts, too. Back in 1959, when Howard McEntee and I battled it out for the National Championship in the "Intermediate" class, Howard was using some sort of an electronic circuit — I think he called it a "Kicking Duck" to pulse a single channel transmitter tone. Luckily for me, it kicked more often than it ducked, and I won, but Howard later on solved his problems and went on to many winning flights in Eastern meets. But we were considered a couple of "tinkerers" then — he electronic and I mechanical.

Now both the electronic and mechanical galloping ghost mechanisms are really coming of age. New combinations are showing up — mechanical devices, together with electronic auxiliaries, making it possible to have pulse rates so fast that the surface movements are almost nil; rudder action with virtually no elevator interaction; instantaneous motor control without flopping surfaces. By the time you read this, the MATS trade show in California, and the Toledo Weak Signals show will be over, and the things I've mentioned will be on the market.

Meanwhile, I hope this column has helped you to understand the very basic principles of galloping ghost.

Let me know!

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