SECTION 4

• MEASURING RECOIL

• SHELL PRESSURE, SHOT SPEED, AND RECOIL

You can't get through a month's shooting magazines without running into a fist full of recommendations about recoil. The reader just has to ask, "If all this stuff worked, why are they still writing about it? Wouldn't the problem have been solved long ago?"

Fourteen years ago I decided to do some testing. My aims were modest—measure recoil, undertake the popular recoil reduction modifications, then retest to see what, if anything, had changed. The challenge turned out to be anything but modest. My shop is filled with the detritus of failed theories, and most of the project is still "in planning" rather than in my data notebooks.

Of the two practical ways to measure recoil—force on the shoulder and speed of gun movement—I have concentrated on the latter. In some degree I prefer it because it gives me more repeatable data, but the main reason is that I am convinced it is the "bottom line" of recoil. It is gun movement that causes shoulder force and if we understand the cause, we'll be a long way to understand the effect.

Earlier in this report I emphasized the need for every measurement system to prove itself. Before using any results, I have to substantiate that my way of measuring gun movement gives an accurate and reliable account of the shell it fires.

In building my recoil device I was by no means breaking new ground. The first chronographs were "ballistic pendulums" and so is mine; it differs from its predecessors only in the details of data acquisition.

The following graph represents results from testing four loadings of a certain powder with charges ranging from 16 to 19 grains. The curves on the left side are pressures. The lowest, 9500 was made by 16 grains, the highest, 12,200 psi, by 19 grains. The lines on the right show the movement of the gun. The steeper the line, the faster the recoil speed. Sixteen grains had the slowest recoil speed, 19 grains the fastest. Each data pair is from a single, representative shot.

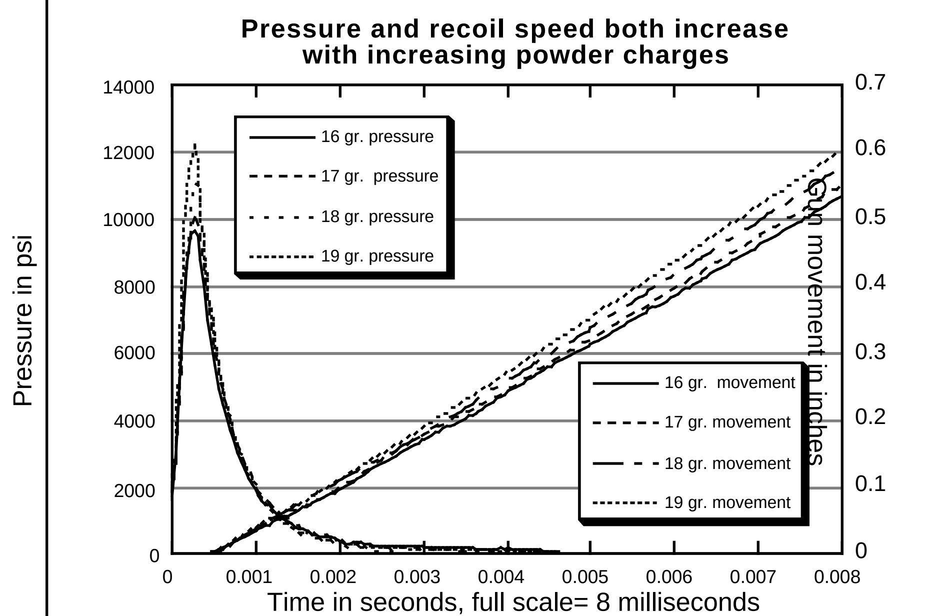

figure 4.1

These data show that the ballistic pendulum used in the following experiments gives an accurate account of the force moving it, just as did its predecessors 100 years ago. Each increase in powder is matched by an increasing speed of recoil. What is not clear is whether the boost in recoil is 1) due to the increase in pressure, or 2) due to the faster shot speed that went along with it. That is the subject of the next experiment.

Do low-pressure powders kick less?

Let's conditionally accept gun speed as "recoil," at least for the purposes of the following experiment, and try to work on the old puzzle "Do low-pressure powders kick less?"

The question as stated is too vague; it has to be made more specific before measurement can answer it. Here it is in a form we can devise a test for: "Does the peak pressure in a shell predict the speed of gun recoil? And if not, what does?"

What are we going to need to answer such a question? In advance, there's really no way to tell. The least we need are some data that vary in recoil speed, pressure, and shot speed, but so far what's going to be useful and what isn't can't be predicted. Let's just start moving forward collecting data and see where the trail leads.

In the following test four types of 1-1/8 oz. trap loads, Handicap, Heavy, Light, and "Lite," all of the same brand were used. Twenty shots of each were fired through the screens of an Oehler 71 inductive chronograph; simultaneous readings were taken of shell pressure and recoil speed. Here are the speeds of the shells:

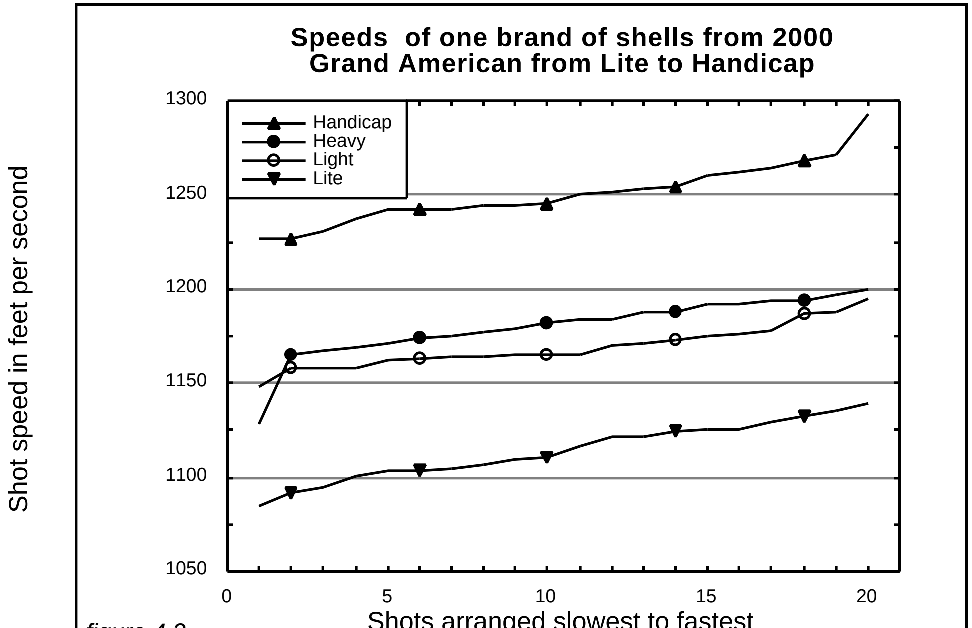

figure 4.2

There are a couple of suspect speeds here: one Handicap is too fast, one Heavy too slow. Pressure and recoil-speed data on those shells support the speed data; I left them in.

In the following graph each data point represents the speed and pressure of one shot. The horizontal axis, shot speed, covers a range of 1050 to 1300 feet per second (fps). The vertical axis spans from 7000 to 11000 pounds per square inch (psi).

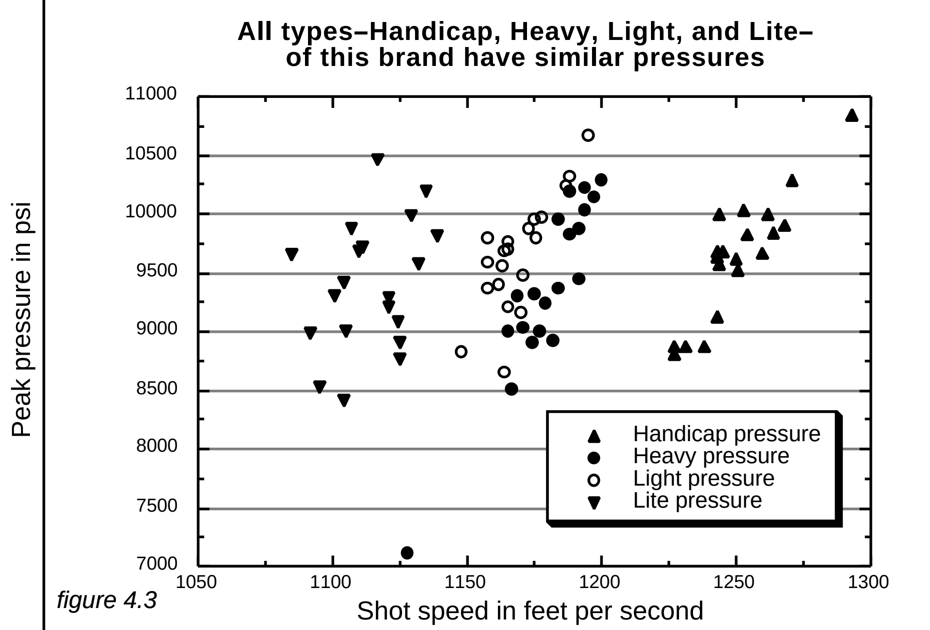

figure 4.3

The critical feature of these shells for this experiment is that they are all about the same pressure. This manufacturer has chosen to build all his shells, from Lite to Handicap, to a peak pressure of about 9500 psi. Other manufacturers use a variety of approaches which change from time to time.

The following graph relates recoil speed, on the vertical axis, to peak pressure, on the horizontal axis. Each data point represents a single shot. The position of the recoiling barrel is measured during the period from 0.002 to 0.004 seconds after ignition, spanning the time when the shot exits the barrel. These measurements are accurate to about 0.005 inches. The position data are subsequently converted to average speed over that 2 millisecond interval.

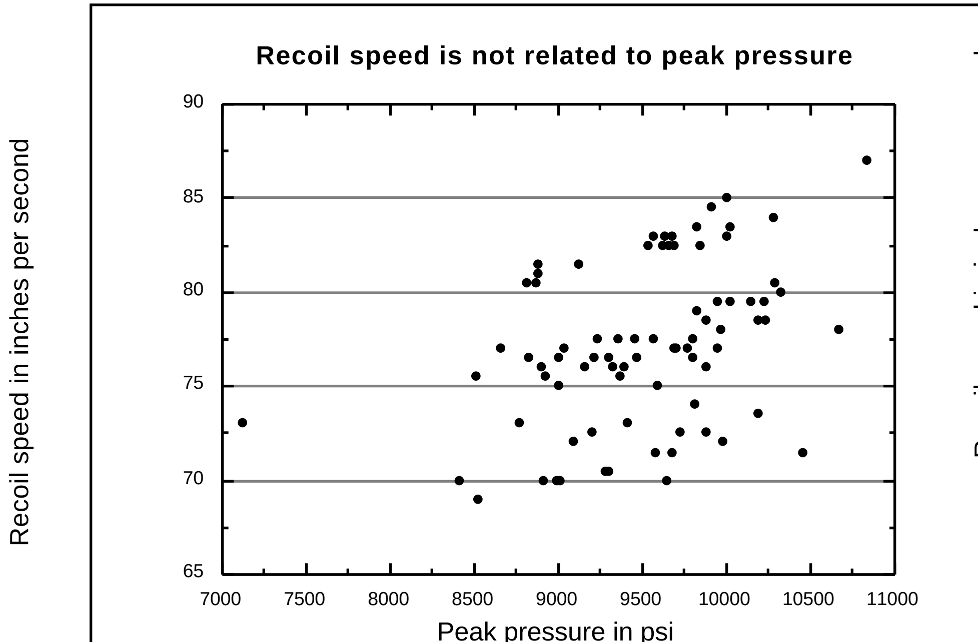

figure 4.4

The title of the graph says it all: "Recoil speed is not related to peak pressure." Shells of low pressure result in both slow and fast recoil speeds, as do shells of high pressure. Remember that these data represent 80 shells ranging from Lite to Handicap so this is not a case of "restricted range" as in figure 3.6. There is plenty of room for the awaited "effect of pressure on recoil" to show up, but it never does.

So far we've graphed shot speed vs. pressure, then pressure vs. recoil. That leaves recoil vs. shot speed as the final relationship to look at.

As in the previous graph, the vertical axis represents recoil speed, but now the horizontal axis represents shot speed.

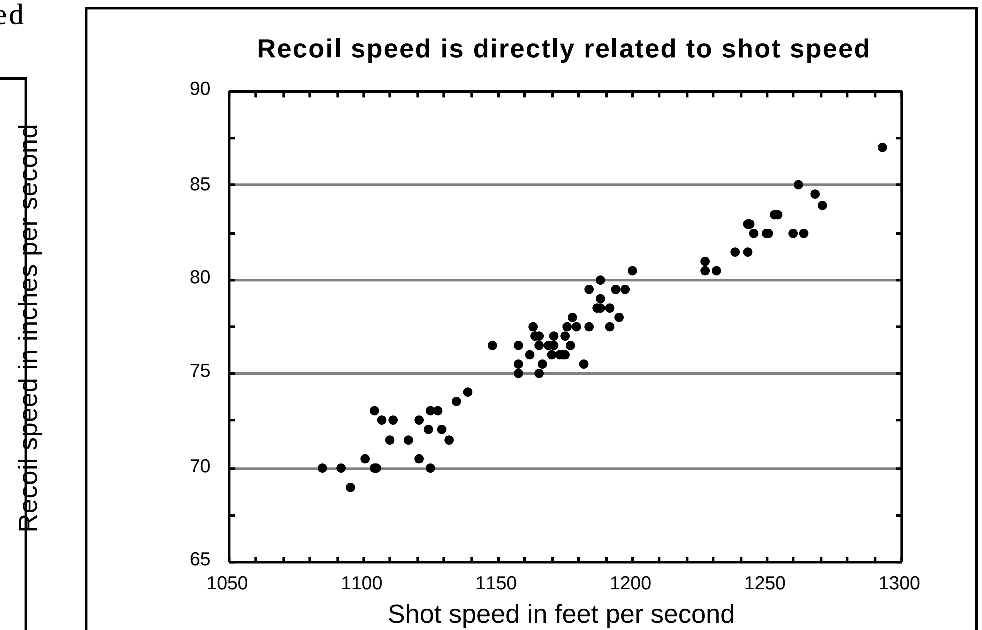

figure 4.5

This is more like it! Here is a set of data points which not only demonstrates a clear relationship, but also integrates the troublesome deviant values at the edges of figures 4.2, 4.3 and 4.4 into a coherent picture. To the extent that the recoil speed of the gun is "kick," we've answered our question. Kick is dependent on shot speed, not peak shell pressure.

The recoil of two kinds of powder

Although the previous experiments all lead to one conclusion, I have not yet done the specific head-to-head comparison of a fast powder vs. a slow one.

For the test below, shells were loaded with Red Dot or PB to produce equal shot speeds. The graph shows the results of a representative shell of each type. Pressure is pictured on the left, the lines rising from lower left to upper right depict gun movement.

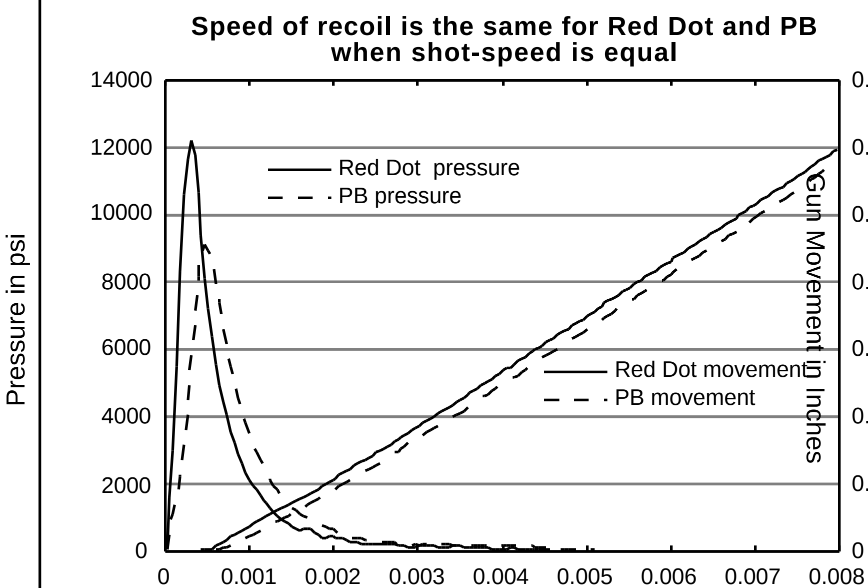

figure 4.3

Although the recoil of the gun produced by PB is delayed by some small fraction of a millisecond compared to that produced by Red Dot, the slope of the two lines, that is the speed of recoil, is just the same. I know there are many shooters who are convinced that they can tell slow from fast powders when they shoot them. These data say that if they can, they aren't using the speed of the recoiling gun to do it.

Summary of Section 4

An instrument from classical physics, the ballistic pendulum, will report increasing shot speed as increasing recoil speed.

Factory shells with similar pressures encompassing speeds from Lite to Handicap were tested. There was no relationship between recoil and peak shell pressure. In contrast, shot speed and recoil speed were strongly related; the faster the shot, the faster the recoil.

A test with prototypical "fast " and "slow" powders showed that they produced the same recoil when their shot speed was the same. This was confirmation that it is shot speed, not pressure, which determines the speed of the recoiling gun.

Afterword

I'd like to thank those of you who followed this journey to the end. Even I, as I reread it, find myself thinking "Won't he *please* get on with it!" What I've tried to do is follow an unbroken trail from our start with first setting up a chronograph to our final goal, an account of recoil.

To the home chronographer I hope I've given confidence in his equipment and help in sorting out at least some of the mysterious results he'll surely to run into.

To the reloader I hope I've given useful information on what goes on in a shell, what kind of consistency he should aim for, and what various powders can, and cannot, do.

And to the merely interested who occasionally want to contribute to a gun club discussion, I hope I've given some "high stopping power" ammunition.