# SECTION 2

- TRAP ANGLE
- INSTRUMENT ALIGNMENT
- TARGET WEIGHT
- TRAP BRAND

## TEST 6a. Angle, height and distance

In Section 1 all the traps were set as closely as possible to the same angle, nineteen degrees, which results in a nine foot target measured ten yards out at normal target speed. These tests describe the changes resulting from changing that angle.

The Pat Trap angle is varied by a simple notched plate. There are eight notches spanning a range from (approximately) seventeen to twenty-four degrees on a properly-leveled trap.

Figure 2.1 shows the general relationship between trap angle and target height at ten yards from the trap. In reality this is may be a more straight-line relationship; the graph however illustrates the fact that there is some always uncertainly where a target was relative to a graduated stake when it went by at 40 mph.

Figure 2.2 confirms what a trap-setter already knows. In still air, the higher the target, the shorter it falls. At reasonable angles the differences aren't great and are often dampened out by random variations. It might seem that there may be only one rational plan to follow in setting targets…height first, then distance, since you will have to redo distance anyway if you change height. But there's another complication: when you speed a target up, it goes higher. In the end, you just do the best you can.

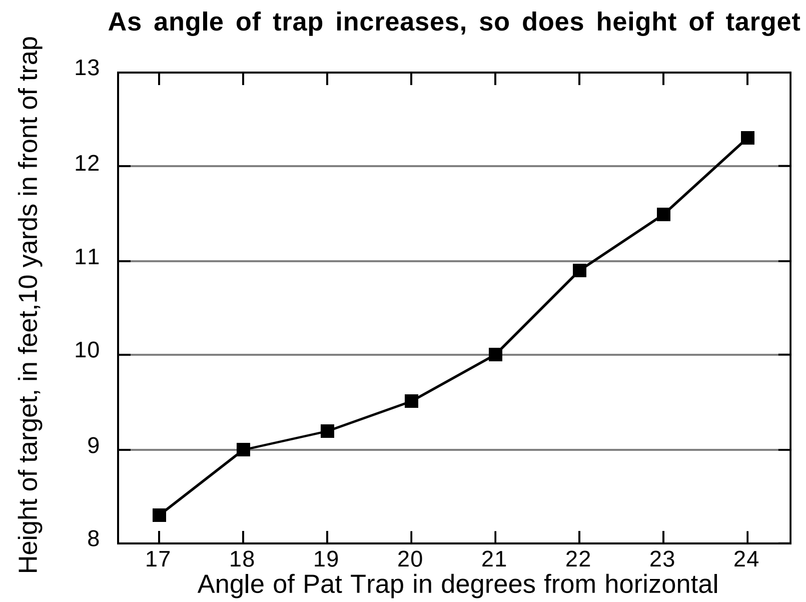



*fig. 2.1*

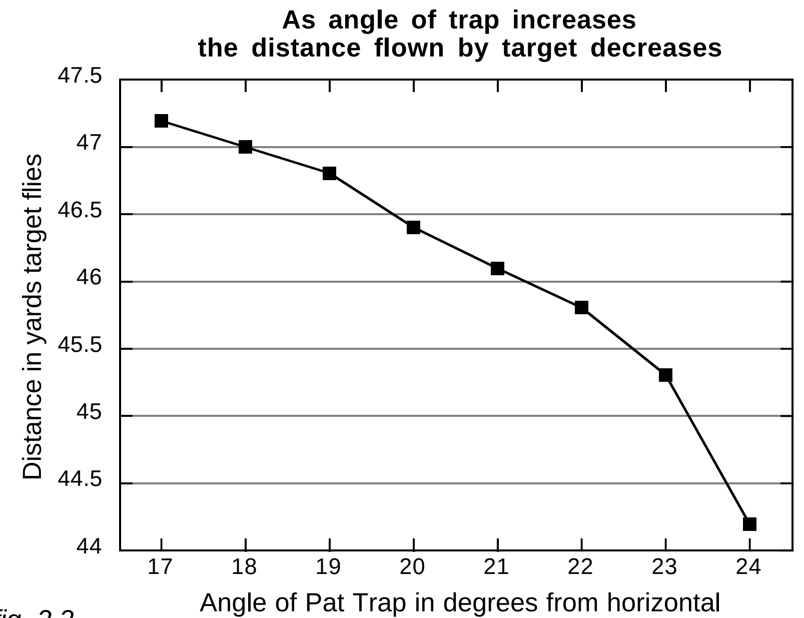



*fig. 2.2*

# TEST 6b. Angle, speed and distance

Figure 2.2 shows that when a target is raised and the spring tension is kept constant, the target falls more and more "short" in step with the higher and higher angle. This subject is worth study in greater detail for reasons I will return to once the data have been presented.

The conditions for Test 6b are as outlined in many tests before: an observer calls the target-fall to the nearest half-yard, there's no wind, it's a comfortable Midwest morning. In this test the targets were started at 48 yards and raised notch-by-notch to maximum height. At each angle, mainspring tension was increased so as to again throw a 48-yard target; ten targets make up each data point.

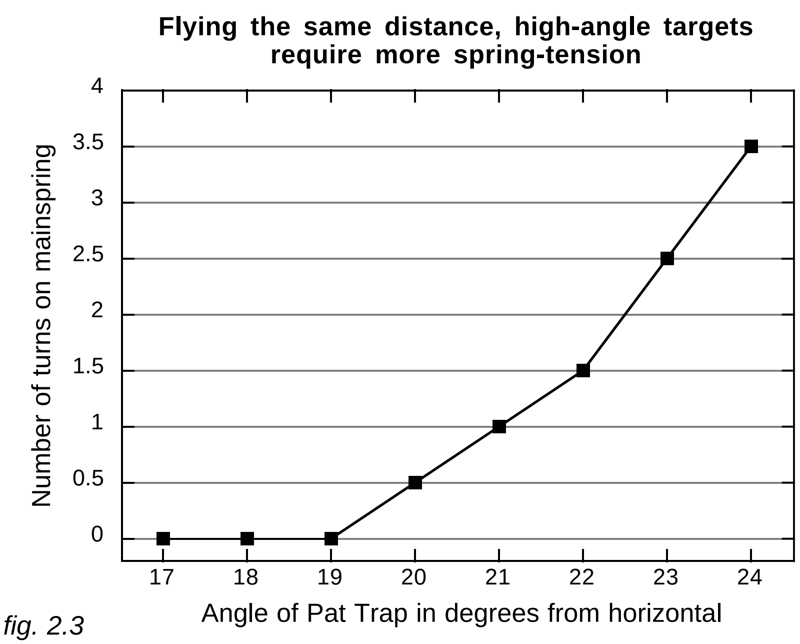



*fig. 2.3*

Once you start getting above a nine-foot target, you have to keep dialing in more and more spring to get the target to your desired distance. Using our rough rule-of-thumb that a Pat Trap turn is worth about a foot-per-second, a foot in height (above nine feet) requires a foot-per-second in speed. The big differences at maximum elevations are of little concern; no one throws them that high anyway.

The first conclusion is that clubs which throw higher targets are also throwing faster targets. There may be overriding considerations – the need to get the targets above a tree line or mountain, for example. Nevertheless, a club which does this as a matter of club policy should take heed of Dean Bright's warning: "Speed Kills."

The second conclusion is more speculative. This report lacks any systematic attention to the effects of wind, but let me tell you one story. We'd set the Forest Lake Sportsmen's Club Pat Traps to 66 feet-per-second on a still Zone Shoot morning. A tailwind came up and we had to raise the targets; we left the spring alone. A gun club manager (not the one from Forest Lake) came to me and correctly pointed out that the targets were falling about five yards short. He suggested that they were slow and would have had me speed them up. Instead I re-chronographed them and confirmed that they were still right on. We left them unchanged in the knowledge that 1) they were in compliance with the intent of ATA rules and 2) they were being shot at when they were going up and not where they were landing.

I see what I am committing myself to. Eventually I'm may have to have to argue that both head- and tail-winds result in"short" targets. I'm counting on figures 2.2 and 2.3 as well as information from later sections to help solve this formidable conundrum

Or will I say head-winds don't cause "short" targets? As yet, I just don't know.

# TEST 7a. Instrument and trap alignment

When a user sets up a chronograph to measure the speed of a target he tries to match the angle of flight with the angle of the instrument, but he can never exactly do it. How important are these inevitable misalignment errors?

If the chronograph were perfectly parallel to the flight path, the distance traversed by the target would be equal to the distance between the sensors. Any misalignment causes the target to go farther than the assumed distance and the speed displayed to be less than the real target speed.

The trigonometric function the cosine predicts the degree to which the true speed will be underestimated. The cosine function predicts small errors (less than 1.5%) at any misalignment angle of less than 10 degrees; at misalignments of less than 5 degrees, the error may be completely ignored.

In Test 7a the Oehler Chronograph was set with a precision bubble level to match the Pat Trap's lowest angle setting of seventeen degrees. The targets were thrown and their speeds recorded. The trap was then raised one notch (about one degree) and ten more targets were thrown, then up another notch and so on. At the trap's maximum height, the misalignment between the target's flight and the chronograph was about seven degrees.

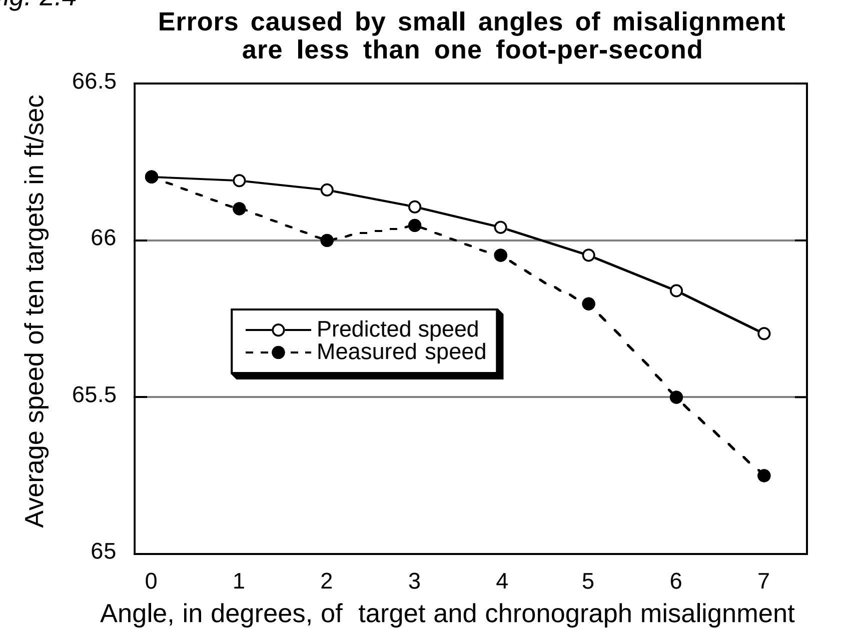
The data collected in this test are presented in the graph to the right. When the trap and chronograph were both at seventeen degrees the measured target speed was 66.2 feet-per-second. The solid line predicts the speed readings based on the cosine of the angle of trap/chronograph misalignment; the dashed line represents the speed readings actually observed.

All the speed errors observed were greater than predicted, but even at maximum misalignment the deviation was only one foot-per-second. At lesser angles the error was inconsequential.

A chronograph can be misaligned vertically, horizontally, or both. A five-degree error in both horizontal and vertical planes combines like two separate five-degree errors (manageable), not a ten degree error (unacceptable).

This test advises the user to observe considerable care in setting up the chronograph – certainly more care than I usually see being employed. The disc is only over the chronograph for about one-

*fig. 2.4*




sixtieth of a second, and a five-degree mismatch is only a inch over the length of the ProChrono. Maybe you an can set the vertical angle close enough from behind a Winchester hand-set, but with a Pat Trap it's impossible. It's also impossible to set the angle from the side with any brand of trap. I've tried it many times and then checked my work with a precision level. Well, I've seen it done and maybe you can do it; I can't.

It's better to set the vertical angle relative to the (uncocked) trap than to the flying target. With the Pat Trap it's easy. Just raise the chronograph high enough so you can sight along the top of it and the trap's flight-plate behind it. Align the two and remember to lower the chronograph again. The hand-set is a bigger problem since you have to sight back to the target arm (which is not parallel to the trap body), but it's still easy to do. Horizontal angle can be set from on top of the traphouse or, with a hand-set, from behind.

As noted before, all types of misalignment lead to readings which are slower than actual target speed, so it's the shooters, not the rules, who suffer from a setter's carelessness. But there *is* a potential problem here, and unless the setter is serious about getting the alignment right, there's no point in using a chronograph.

# TEST 7b. A different way to align the chronograph.

When you buy a ProChrono from Frenchy Frigon you also get a two-page monograph authored by James Brown of Nebraska. It is a practical guide to using a chronograph, but it reports getting fifty-yard targets with a launch speed of 64 feet-per-second, while I usually need 68 feet-per-second to get the same fifty yards. Why the difference?

I sent an early copy of this report to Jim and he saw the cause immediately. Rather than labor to align the chronograph with the target-flight, as I have done, he aligns the chronograph with the ground. That is, the instrument is horizontal, not tilted. With a little stick-on bubble level from an RV shop he can get this horizontal positioning with high repeatability and has none of the alignment problems I detailed in the previous section.

We agreed that the two numbers – my 68 fps and his 64 fps – are really reporting the same speed target and here's why: When you align the chronograph with the target flight-line (tipped up twenty degrees) you read the actual speed of the target. When you set the chronograph horizontally you read a reduced speed; the reduction is a function of the angle between the flight-line and the ground, commonly about twenty degrees. As noted in test 7a, the indicated speed will be the actual speed multiplied by the cosine of the angle of misalignment. The cosine of twenty degrees is 0.93 and 68 fps (the speed I get for fifty-yard targets) multiplied by 0.93 is 64 fps (James Brown's speed). So the speeds really are equivalent.

There is a difference between just calculating a predicted difference and actually demonstrating it, so I needed a test. I set up the ProChrono with a 20 degree tilt up, matching the flight of a target off a Pat Trap. I threw ten targets at 68 fps and saw that they flew fifty yards. Then I lowered the ProChrono to horizontal using a bubble level and threw ten more targets. I then repeated the procedure, throwing ten targets with the chronograph at 20 degrees, ten more with it horizontal. The results are displayed at the right.

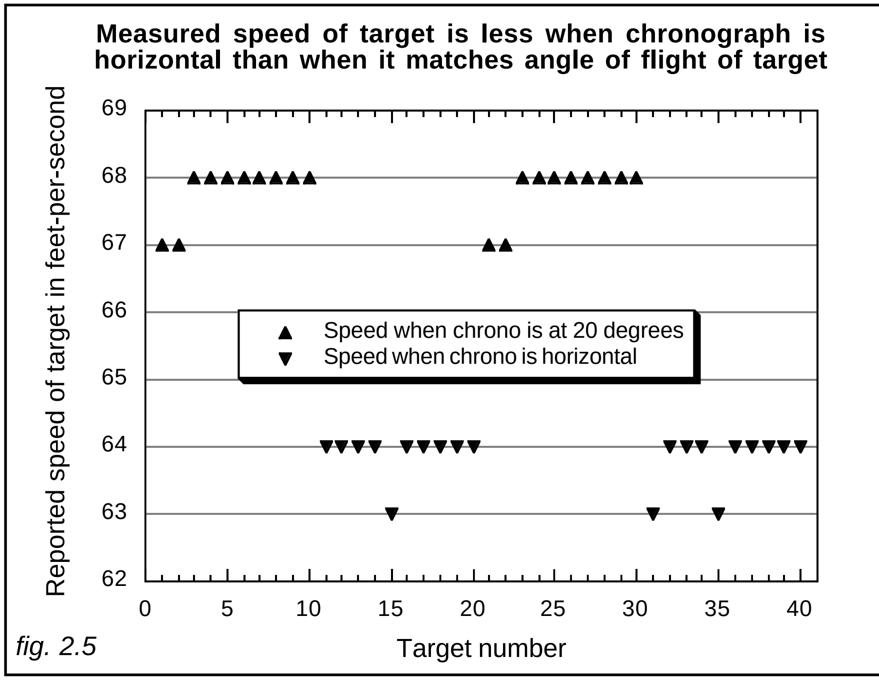


*fig. 2.5*

As you can see, when the chronograph is lowered from twenty degrees to horizontal, the target-speed reading is reduced from 68 fps to 64 fps. The two ways of setting up the chronograph result in speed-readings which differ by four feet-per-second though the target speed is unchanged.

Which way should the chronograph be set, tilted or horizontal? For my research, tilted was my choice. The effect of error is minimized: a one-degree mismatch when tilted causes a misreading of less than one-tenth of one percent, a mismatch of a degree when horizontal leads to an error of about half a percent. Neither error is of any consequence, but more accurate is better, so I tilted the chronograph.

For practical target-setting there is really no difference in accuracy, but I have come to favor horizontal, the way Jim Brown does it. With all the problems of matching the angle of the chronograph to the target-flight described in Section 7a, it just makes more sense to set the instrument horizontally with an attached bubble level and throw the target 63 fps for a 48-yard target, 64 fps to get a full 50-yard target.

# TEST 8. Distance of Chronograph from trap.

As soon as a target leaves the trap it begins to lose speed. Common sense tells us to try to set the chronograph the same distance from every trap, but how much error is introduced if we can't do this every time?

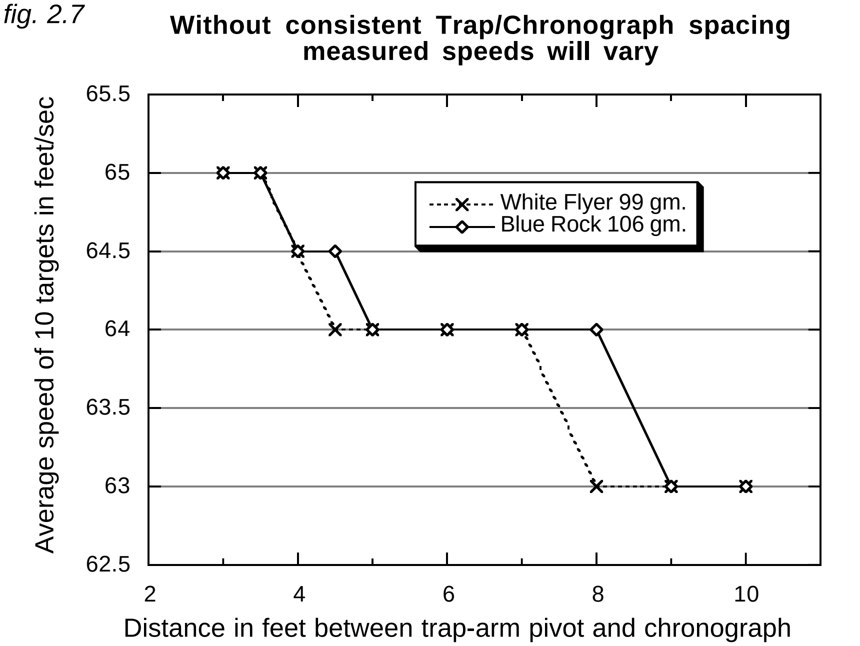
The picture at the upper right shows the equipment used in Test 8. The chronograph was mounted on the long wooden arm, with its midpoint starting at three feet from the trap pivot. Ten White Flyers were thrown, the ProChrono moved a half-a-foot along the arm, ten more targets, and so on until the maximum distance of ten feet was reached. The test was then duplicated with Remington targets.

Data was graphed using the mode, the most common reading, as the average. Over the distance ordinarily used, three to five feet between the chronograph and trap, the target loses about a foot-per-second in speed. There isn't much difference between the 107 gram Remingtons and the lighter (99 gram) White Flyers.

As the graph illustrates, speed readings are not particularly sensitive to variations in trap/chronograph distance; it takes a two-foot change to make a one foot-per-second difference. If the user just tries to keep the distances about the same, that is good enough.

*fig. 2.6*

*fig. 2.7*



# TEST 9a. Brand of Target: Introduction

It is time to return to the question of generality. In Test 8 we used two different brands of targets looking at only the first few feet of flight. Now we are going to expand the multi-brand trajectory to include the whole fifty yards. When we use chronographs for setting do we have to make any allowances for the brand of target we happen to be throwing?

The table at the bottom of the page summarizes the results of Test 9; what follows here is a description of the experiment as it developed.

Weather, time, and observer were as usual; I used Pat Trap #2 at Metro for the whole test.

Condition 1. Ten Winchester White Flyers were thrown; the Oehler chronograph reported their speed as 65.5 feet-per-second. They flew an average of 46 yards.

Condition 2. Without changing anything on the trap, Remington Blue Rocks were substituted for the White Flyers. They went about one foot-per-second slower (64.7 vs 65.5), and landed about a yard shorter, which is just the distance that would be expected at this reduced speed.

Condition 3. Again, no change in the trap, Federal Champions were thrown. They went faster, 68 feet-per-second, and flew farther, 49 yards.

Condition 4. This was a replication of Condition 3 (Federals), and gave substantially the same results.

Condition 5. White Winchester White flyers were thrown, the results were no different from the same brand of orange dome used in condition 1.

Condition 6. A replication of Condition 2 (Remingtons) to control for unexpected changes in the trap. Result were as in Condition 2; the trap hadn't changed.

Condition 7. Federal Champions were thrown again. Spring tension was reduced by three turns to get the speed down to the range of the other two brands. Speed was 65 feet-per-second, distance was 46 yards.

Condition 8. Three turns were restored to the spring and the Federals again flew as they had in condition 4. This was another control for changes in the trap and once again none were found.

Summary: At a given spring-tension, Remington Blue Rocks left the trap at the slowest speed and flew the shortest distance. White flyers were a little faster and flew a little farther. Federal Champions were, on the average, three feet-per-second faster and flew three yards farther. *All three brands of targets, when thrown the same speed (64.7 to 65.5 feet-per-second), flew the same distance (45 to 46 yards).* Though this is very limited data (which will be expanded on in Test 9c) it appears that when setting targets by chronograph no compensation must be made for different brands of target.

**All brands fly the same distance when launched at same speed**

| condition | Brand | speed ft/sec | distance in yds |
|---|---|---|---|
| condition 1 | W.Flyer orange | 65.5 | 46.0 |
| condition 2 | Remington | 64.7 | 45.0 |
| condition 3 | Federal | 68.0 | 48.5 |
| condition 4 | Federal again | 67.6 | 49.0 |
| condition 5 | W.Flyer white | 65.4 | 46.0 |
| condition 6 | Remington again | 64.6 | 45.0 |
| condition 7 | Federal minus 3 turn | 65.0 | 45.0 |
| condition 8 | Federal plus 3 turn | 67.8 | 49.0 |

*fig. 2.8*

# TEST 9b. Target Weight

The three most popular brands of trap targets can be roughly divided into two weight categories, heavy and light. Two brands are of similar weight, the third differs from the other two by about 8%. Test 9a showed that Remingtons and Winchesters were very similar in off-the-trap speed and flight distance while the Federals came off a similarly-tensioned trap faster and flew further. The obvious conclusion is that the first two (Remington and Winchester) are of similar (heavy) weight, while the third is lighter. Obvious, but wrong. It is the Federals (97 grams) and Winchesters (98 grams) which are alike; it's the Remingtons which are way out there alone at 106 grams.

This result is so unexpected and so unbelievable that I replicated the experiment twice looking for errors. First I did Test 9a over again a week later and got the same results. Then I returned and conducted a more systematic and complete investigation; the results of the last test are summarized in the upper graph at the right. To facilitate comparison with Test 9a I've anchored "zero" on the horizontal axis (the X-axis) to a mid-range White Flyer.

This graph is best understood by picking a point on the X-axis, for example "0." At this spring setting the Remingtons are flying 44 yards, the white and orange Winchesters 44.5 and 45 yards respectively, the Federals 48 yards. Other points on the X-axis yield similar results. Once again, the Winchesters were more like the heavier Remingtons than like the Federals whose weight they closely match.

The lower graph is a partial replication of the first experiment using a Winchester 1524 hand-set trap instead of the Pat Trap. By this time I had run out of Federal targets so the test is incomplete, but the result, that lighter (98 gram) Winchesters fly considerably farther than heavier (106 gram) Remingtons is a least provisional counter-evidence to the data presented above.

At the present I can't explain these results. As this report is extended and refined in the future I hope the solution will make itself known.

Let me emphasize that the data on this page relate spring tension to flight distance, not speed to flight distance. Just to make sure there is no misunderstanding, I'm going to back to brand/speed/distance in test 9c.

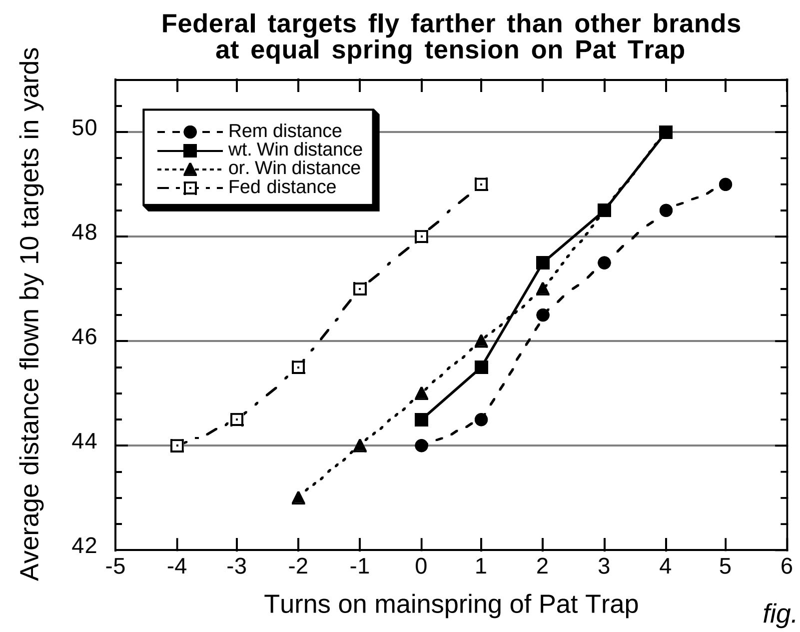



fig. 2.9

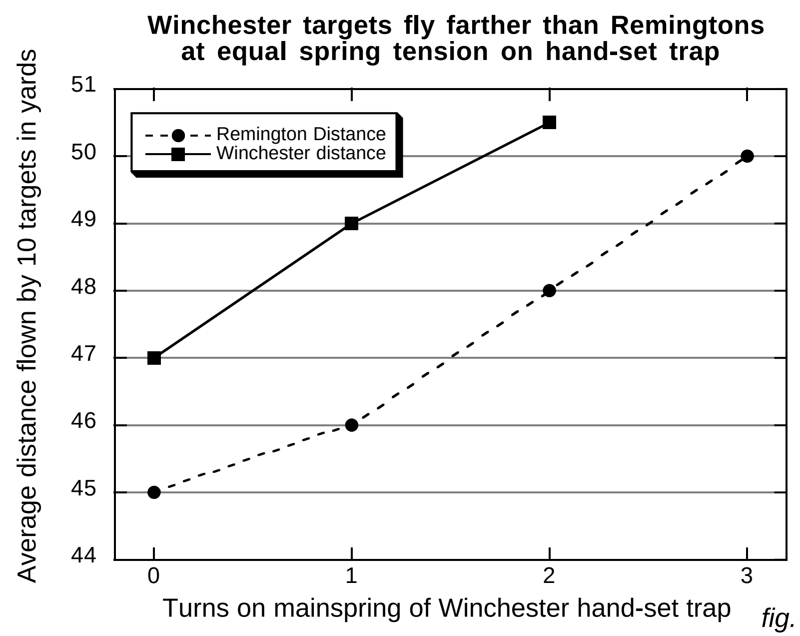



fig. 2.10

# TEST 9c. Brand of Target: Conclusion

Two pages ago I said “Though this is very limited data…it appears that when setting targets by chronograph no compensation must be made for different brands.”

The digression into target weight has muddied the water; now I need more evidence to support that initial conclusion.

The two graphs at the right come from the same experiments I reported on the last page, but in these examples the X-axis represents the speed of the target, not tension on the mainspring. The Y-axis remains the same, and depicts the average distance flown by the targets.

The upper graph (figure 2.11) covers the same data as the previously seen figure 2.9. The Oehler chronograph measured the speed of ten targets of each brand at each of at least six speeds while an observer at the fifty-yard stake reported the landing spot. The data points, while not identical, are so close and so intermingled that no consistent differences between brands can be seen.

Figure 2.12 (right, below) shows this intermingling in another way. This scatter plot pictures the distance flown by each individual target, Remington and Winchester, thrown from a hand-set at three or four speeds. Again, the data points are too mixed together to support any argument that the two brands fly differently.

The scatter plot also illustrates another similarity between these brands. The horizontal scatter of one brand in one of the data-clusters represents the range of speeds resulting from one spring setting, and it’s about one-half foot-per-second in all cases. The vertical scatter of one brand in a cluster represents the range of distances resulting from one spring setting. This is more variable – a yard-and-a-half to two yards is usual with only one group, the Winchesters at 68 feet-per-second, falling within just one yard. The similarity of all these clusters, taken all together, make it clear that neither of these brands is any more consistent than the other either in speed off the trap or in length of flight.

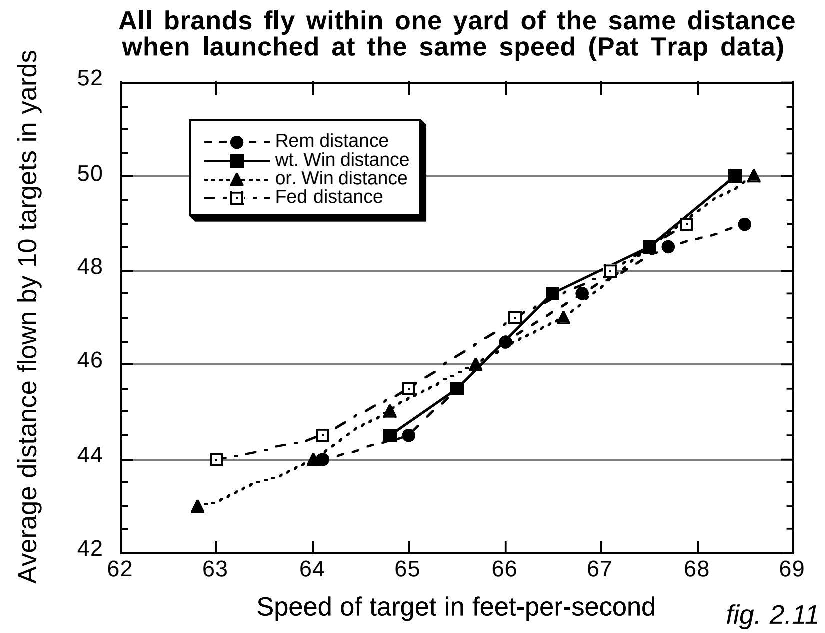



*fig. 2.11*

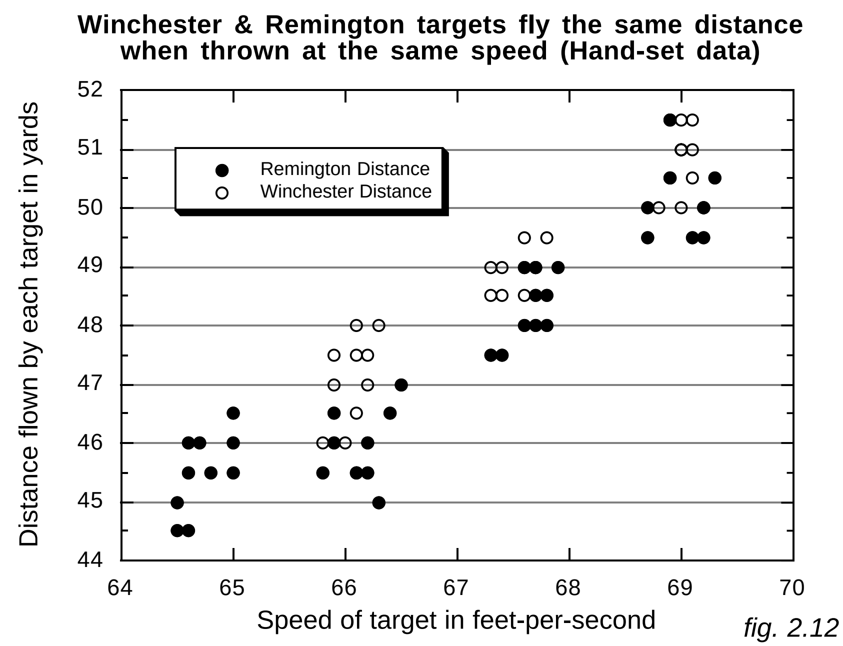



*fig. 2.12*

# TEST 10. Pat Trap & Hand-set

Just as we asked in the last test if we had to make some speed compensation based on the brand of target we throw, so should we ask if the type of trap makes any difference.

The two scatter plots at the right depict randomly-selected data from tests run using Remington and Winchester targets thrown from Pat Traps and hand-sets. The data in the filled circles come from the former, the open circles from the latter.

In terms of the distance a target of a certain speed flies, there is not a shred of difference between automatic and hand-set traps; neither is there any difference in the variability of target speed from either machine.

In addition, these data reconfirm previous findings about the brands of targets: there's no difference between the flight of White Flyers and Blue Rocks either in variability or length.

# Summary of Section 2

Test 6 showed that a high target requires much more speed to reach the stake than one thrown even just a little lower.

The next three tests investigated the degree of care needed in chronography. The user has to decide if he will try to match the angle of the chronograph with the angle of target flight (difficult), or just set the instrument horizontally and get on with it. I recommend the latter. Small variations in chronograph/trap distance don't make much difference.

The rest of the section tested some of the assertions we've all heard about differences among traps and targets. It turns out that to both a chronograph and fifty-yard stake, a trap is a trap and a target a target. No compensation need be made for brand of trap or target.

But there are two last challenges to generality – weather and altitude. Section 3 will cover those issues, as well as give some tentative explanations for what we've seen so far.

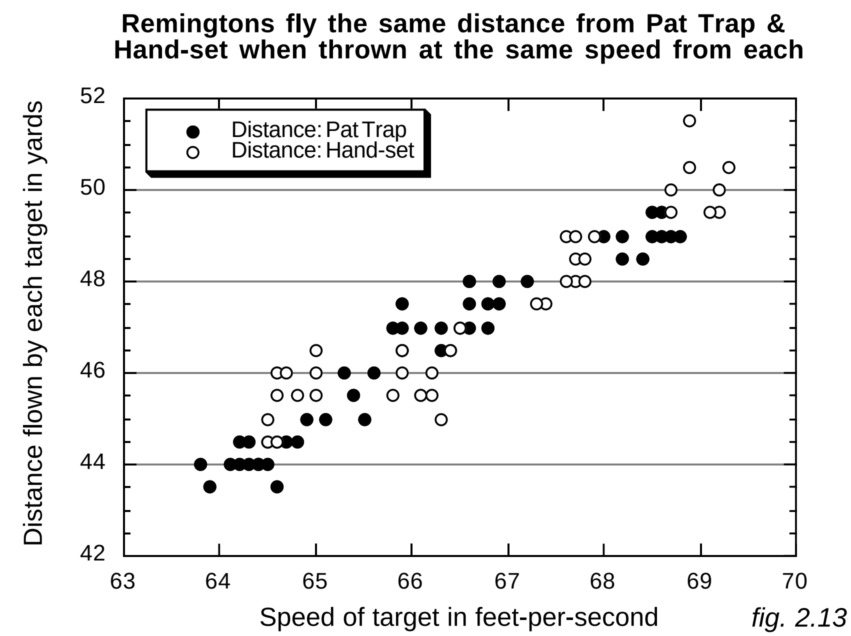


*fig. 2.13*

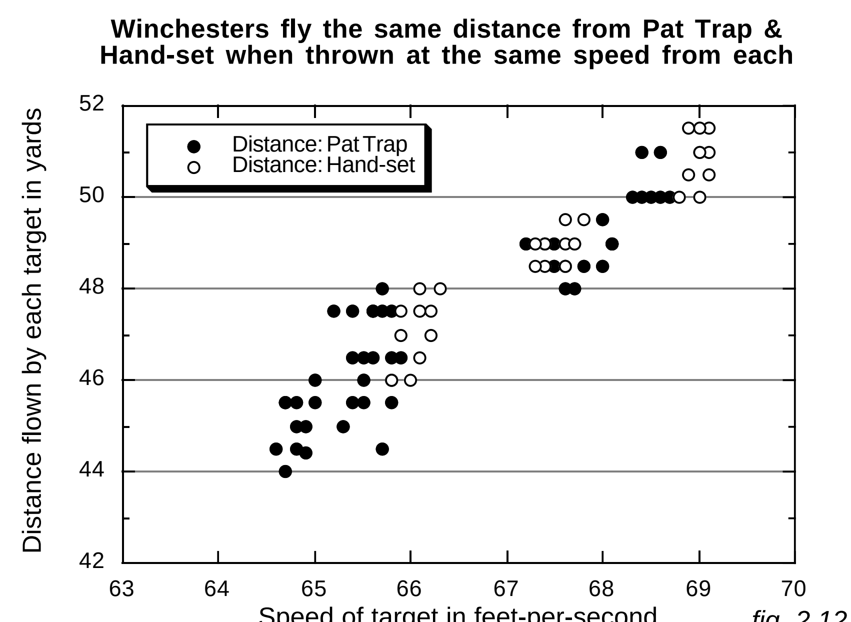


*fig. 2.12*