WHEELING IN MARCHING, OR ON A MOVABLE PIVOT”

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At drill day we tried to reconcile the instructions for the maneuver for wheeling while being in motion.

- 1. *Right (or left) wheel*. 2. MARCH.
- 408. The first command will be given when the rank is yet four paces from the wheeling point.
- 409. At the second command, the wheel will be executed in the same manner as from a halt,
    - 1. *By squad, right wheel*. 2. MARCH.
    - 397. At the second command, the rank will step off with the left foot, turning at the same time the head a little to the left, the eyes fixed on the line of the eyes of the men to their left; the pivot-man will merely mark time in gradually turning his body, in order to conform himself to the movement of the marching flank; the man who conducts this flank will take steps of twenty-eight inches, and from the first step advance a little the left shoulder, cast his eyes from time to time along the rank, and feel constantly the elbow of the next man lightly, but never push him.
    - 398. The other men will feel lightly the elbow of the next man toward the pivot, resist pressure Coming from the opposite side, and each will conform himself to the marching flank-shortening his step according to his approximation to the pivot.
- (409 continued) except that the touch of the elbow will remain toward the marching flank (or side of the guide) instead of the side of the actual pivot; that the pivot man, instead of merely turning in his place, will conform himself to the movement of the marching flank, feel lightly the elbow of the next man, take steps of full nine inches, and thus gain ground forward in describing a small curve so as to clear the point of the wheel. The middle of the rank will bend slightly to the rear. As soon as the movement shall commence, the man who conducts the marching flank will cast his eyes on the ground over which he will have to pass.
- 416. When the recruits comprehend and execute well, in quick time, the wheels at a halt and in marching, and the change of direction to the side of the guide, the instructor will cause the same movements to be repeated in double quick time.
- 417. These various movements will 'be executed by the same commands and according to the same principles as in quick time, except that, the command double quick will precede that of march. In wheeling while marching, the pivot man will take steps of eleven inches, and in the changes of direction to the side of the guide, the men on the side opposite the guide must increase the gait in order to bring themselves into line.

Don pointed out that there is a simple formula from geometry we can use to help answer our questions (Stay in school boys!):

Arc length = (circle radius) * (central angle)

The challenge is that we know neither the circle radius nor the arc's central angle. However, we do know that when wheeling, the soldiers maintain the same rate of step or cadence, they just shorten the length of step depending on their position in the ranks. Just like the spokes of a wheel, the marching ranks of soldiers scribe the same central angle. Since we do know the arc length of two concentric circles, we can determine the diameter of the imaginary hub our marching rank is connected to.

Reference image from Library of Congress collection, described as: "The Peninsula, Va. A 12-pdr. howitzer gun captured by Butterfield's Brigade near Hanover Court House, May 27, 1862"

We know that the soldier on the pivot flank takes steps of 9 inches or 11 inches depending on whether they are marching at Quick Time or Double Quick Time respectively. We also know that the soldier on the wheeling flank takes steps of 28 inches or 33 inches depending on whether they are marching at Quick Time or Double Quick Time respectively.

Arc length = (circle radius) * (central angle)
L_W = arc length of the wheeling flank
L_P = arc length of the pivot flank
R_P = radius of circle scribed by the pivot flank. This is the radius of the "wagon wheel" hub.
R_W = radius of circle scribed by the wheeling flank.
L_R = length of the wheeling rank

The radius of the wheeling flank is comprised of the distance from the point of the circle to the pivot flank, which equals the pivot radius, plus the length of the wheeling rank.

$R_W = R_P + L_R$

The angles scribed by the wheeling flank and the pivot flank are the same!

A_W = the central angle scribed by the wheeling flank soldier
A_P = the central angle scribed by the pivot flank soldier
$A_W = A_P$

The formula for the arc length of the pivot flank can be written as:

Arc Length Pivot Flank = = $R_P * A_P$
11 inches = $R_P * A_P$

Solve for the central angle

(11 inches) / $R_P = A_P$

The formula for the arc length of the wheeling flank can be written as:

Arc Length Wheeling Flank = $R_W * A_W$
33 inches = $R_W * A_W$

Substitute for the radius of the wheeling flank

33 inches = $(L_R + R_P) * A_W$

Since the angle scribed by the Pivot Flank and the Wheeling Flank soldiers are the same, use the values from the Pivot flank equation, substitute for the Central Angle of the arc scribed by the wheeling flank.

33 inches = (L_R + R_P) * (11 inches / R_P)
33 inches * (R_P / 11 inches) = (L_R + R_P)
3 * R_P = L_R + R_P
2 * R_P = L_R
R_P = ½ * L_R

The radius of the circle scribed by the pivot flank is half the length of the marching flank!
And, solving for the radius of the wheeling flank:

R_W = L_R + R_P
R_W = L_R + ½ * L_R
R_W = 3/2 * L_R

The radius of the circle scribed by the wheeling flank is one and a half times the length of the marching rank.

Assume the average elbow-elbow width of a (typical) soldier is 24 inches. When the rank is composed of four men, the marching rank is approximately 8 feet long, which means the arc scribed by the pivot flank soldier, lies along the circumference of a circle that has a 4 foot radius and the arc scribed by the wheeling flank lies along the circumference of a circle that has a 12 foot radius.

Solving for the radius of the wheeling flank, with a 4 man front, 8 foot long:

R_P = ½ * L_R
R_P = ½ * 8 feet = 4 feet

R_W = L_R + R_P
R_W = 8 feet + 4 feet = 12 feet

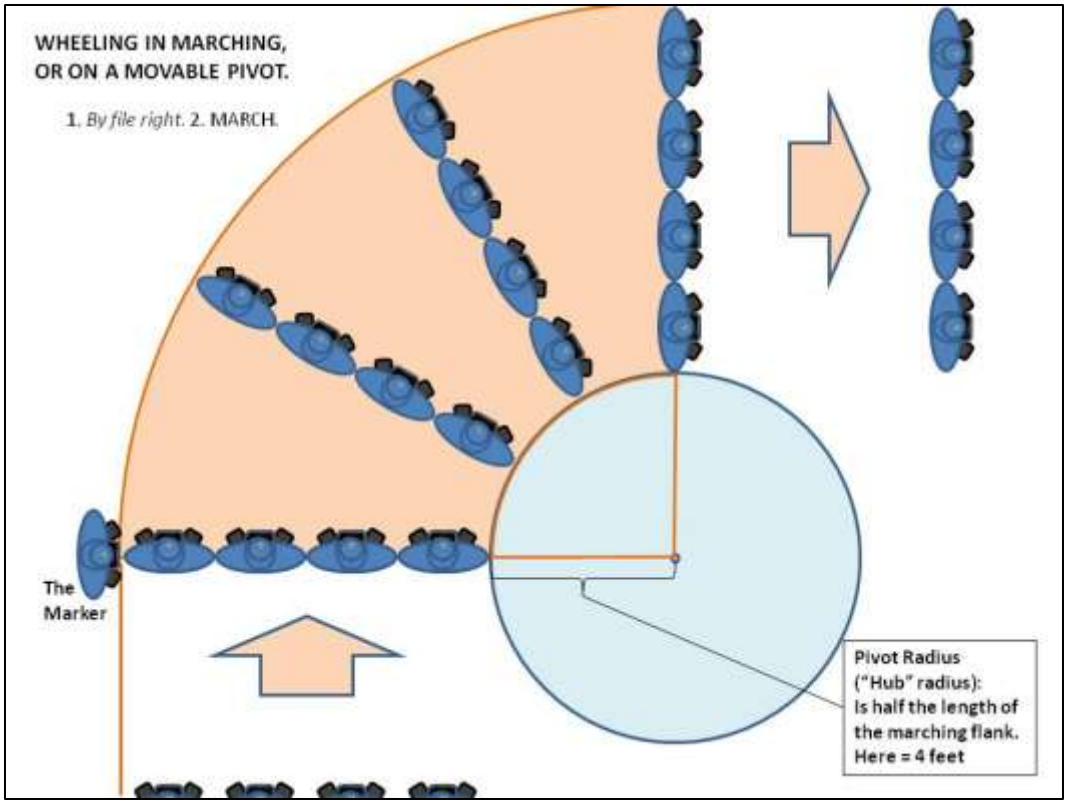
Alternatively calculated

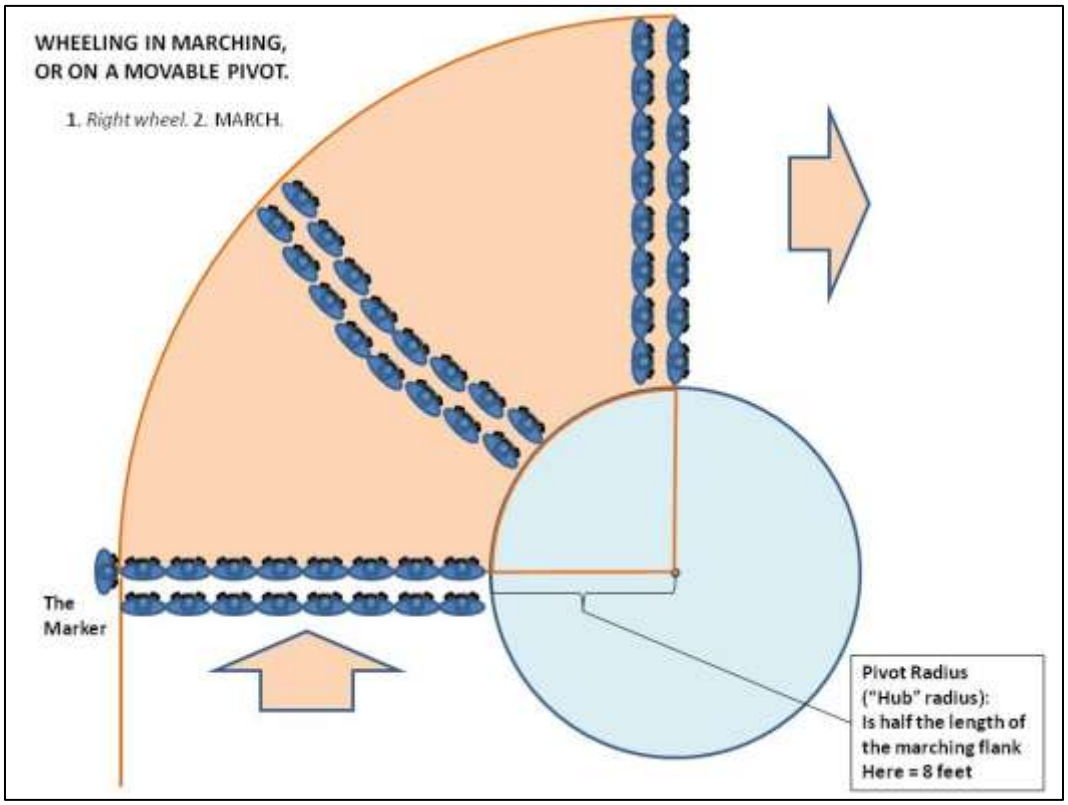
R_W = 3/2 * L_R
R_W = 3/2 * 8 feet = 12 feet

For an idea of scale, this means that for a company of 100 men, 50 men would be in the front rank and the marching rank would have an average length of 100 feet (Assuming the average elbow-elbow width of a (typical) soldier is 24 inches).

Pivoting flank radius = R_P = ½ * L_R = ½ * 100 feet = 50 feet

Wheeling flank radius = R_W = 3/2 * L_R = 3/2 * 100 feet = 150 feet


WHEELING IN MARCHING,
OR ON A MOVABLE PIVOT.
1. By file right. 2. MARCH.
The
Marker
Pivot Radius
("Hub" radius):
Is half the length of
the marching flank.
Here = 4 feet


WHEELING IN MARCHING,
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Confirmation of this math can be found in instructions in the School of the Company for turns and wheelings: Article III, "To Change Direction", includes instructions 216-235.

School of the Company Instructions 216-218 talk about the positions of guides and the "marker". Instruction 230 emphasizes the importance of the "marker" for the wheel point.

216. The changes of direction of a column marching, will be executed according to the principles prescribed for wheeling on the march. Whenever, therefore, a column is to change direction, the instructor will change the guide, if not already there, to the flank opposite the side to which the change is to be made.

217. The column being in march right in front, if it be the wish of the instructor to change direction to the right, he will give the order to the chief of the first platoon, and immediately go himself, or send a marker to the point at which the change of direction is to be made; the indicator or marker, will place himself on the direction of the guides, so as to present the breast to that flank of the column.

218. The leading guide will direct his march on that person, so that, in passing, his left arm may just graze his breast. When the leading guide shall have approached near to the marker, the chief of his platoon will command:

1. *Right wheel*. 2. MARCH.

219. The first command will be given when the platoon is at the distance of four paces from the marker.

220. At the command *march*, which will be pronounced at the instant the guide shall have arrived opposite the marker, the platoon will wheel to the right, conforming to what is prescribed in the *S. S.*, No. 409.

221. The wheel being finished, the chief of each platoon will command:

3. *Forward*. 4. MARCH.

230. It is highly important, in order to preserve distances and the direction, that all the subdivisions of the column should change direction precisely at the point where the leading subdivision changed; it is for this reason that that point ought to be marked in advance, and that it is prescribed that the guides direct their march on the marker, also that each chief of subdivision shall not cause the change to commence till, the guide of his subdivision has grazed the breast of this marker.

School of the Company Instruction 231 echoes what we often preach to our troops, when we say: "square off the turn", and "don't anticipate".

231. Each chief will take care that his subdivision arrives at the point of change in a square with the line of direction: with this view, he will face to his subdivision when the one which precedes

has commenced to turn or to wheel, and he will be watchful that it continues to march squarely until it arrives at the point where the change of direction is to commence.

School of the Company Instruction 232 explains why when wheeling in motion it is important for both sides of the flank to make forward motion. It is necessary in order to avoid creating a massive traffic jam: "… in order not to arrest the march of the next subdivision." It also mentions "… an arc in length about once and a half the front of the subdivision, …". The phrase "arc in length" is a reference to the radius of the arc. The "once and a half the front of the subdivision" matches the math that determined that the wheeling flank's radius.

232. If, in changes of direction, the pivot of the subdivision which wheels should not clear the wheeling point, the next subdivision would be arrested and distances lost; for the guide who conducts the marching rank having to describe an arc in length about once and a half the front of the subdivision, the second subdivision would be already up with the wheeling point, whilst the first which wheels has yet the half of its front to execute, and hence would be obliged to mark time until that half be executed. It is therefore prescribed, that the pivot of each subdivision should take steps of nine or eleven inches in length, according to the swiftness of the gait, in order not to arrest the march of the next subdivision. The chiefs of subdivision will look well to the step of the pivot, and cause his step to be lengthened or shortened as may be judged necessary. By the nature of this movement, the centre of each subdivision will bend a little to the rear.

233. The guides will never alter the length or the cadence of the step, whether the change of direction be to the side of the guide or to the opposite side.

234. The marker, placed at the wheeling point, will always present his breast to the flank of the column. The instructor will take the greatest pains in causing the prescribed principles to be observed; he will see that each subdivision only commences the change of direction when the guide, grazing the breast of the marker, has nearly passed him, and, that the marching flank does not describe the arc of too large a circle, in order that it may not be thrown beyond the new direction.

235. In change of direction by wheel, the guide of the wheeling flank will cast his eyes over the ground at the moment of commencing the wheel, and will describe an arc of a circle whose radius is equal to the front of the subdivision.

In order to "describe an arc of a circle whose radius is equal to the front of the subdivision", the wheel described in 235 would have to be executed at a halt. The math formula indicates that when wheeling at the march, the wheeling flank describes an arc of a circle whose radius is one and a half times the front of the subdivision.