Thick Line Grids for Metric Pictures

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Must be printed "actual size", not "fit to printable area".

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1 Accuracy of the Grid figures

In the "old days", engineering and architecture used special paper with precisely drawn grids. These were used for many parts of design and analysis of systems. Recently (for the last 30 to 40 years) computers are available that can do plots of information more accurately and easil than hand drawn figures. Thus new "engineering" grid paper is difficult to find. The old companies seem to have stopped printing these special types of grid paper.

It is convenient to be able to take pictures of flat complex objects (such as crosscut saw teeth, etc.) with a grid in the background. Then the exact shape of the items may be determined by looking at the photograph. I usually use my cell phone for these pictures. This section is provided to enable anyone that wants to reproduce my results with a set of common grid paper that they may printout as and when desired.

1. Accuracy of the Grid figures is controlled by the quality of the printer used to print it on and the number of times that the individual Grid figure has been reproduced from an original.

2. The generated PDF file is correct, however the actual printing process sometimes introduces sizing errors. When paper is wrapped around a drum, as it is with many laser printers, one surface is longer (the side that is on the outside of the circle so its radius is slightly longer than the other side).

3. While the paper direction that is transverse (landscape) to the cylinder is almost always "correct". This results in dimensions in one direction being somewhat better than those in the longitudinal (portrate) direction.

4. Some printers do not produce 100% size output by default. Some of them default to '"fit the image for printing". On two different printers that I tested on, this option is the default option and the printed image is at 90% or other % of the "true" size. When "accurate" output size is obtained, measurements may be "off".

5. Since these Grids are at standard sizes "calibration" marks are provided an estimate of the amount of "printing error" that has been introduced to any given target. If the Grid is checked with an accurate machinist's ruler an indication of the dimensional errors that have been introduced to the copy at hand may be estimated. For many uses the introduced error may be ignored.

6. If it is necessary that verify that the printed Grid was the "correct" size I used machinist's rules from three different manufactures. I consider them all to be of about equal accuracy. They are:

   - GENERAL, model CF1216 with inch measure in 10ths/50ths on one side and inch measure in 32ths/64ths on the other side. It is 10 inches long.
   - MITUTOYO, model 182-223 with inch measure in 32ths/64ths on one side and inch measure in 10ths/50ths on the other side. It is 10 inches long.

- L.S.STARRETT, model C334 with inch measure in 10ths/50ths on one side and metric measure in full mm/$\frac{1}{2}$mm on the other. It is 10 inches long.
- L.S.STARRETT, model CF616 with inch measure in 10ths/50ths on one side and inch measure in 32ths/64ths on the other side. It is 5 inches long.

7. The dimentional stability of paper varies in several ways:

   - Paper tends to change its size based on the temperature and humidity.
   - Paper changes it size depending if it is measured longitudinally or traversly as to the way it was processed in the paper plant. I.e. the amount of change may be different for left-right and top-bottom directions on the same sheet of paper. This is because paper is made in large rolls and then cut to size later.

8. When using these Grid figures, it is the responsibility of the user to determine if the figure has a acceptable accuracy.

Originally engineering grids were available in several different formats. Most of these are obsoulete such as "Triangular coordinate", "Probablility", and the ever popular "Quadratic Coordinate". (There are many others.) One company "National Blank Book Company" lists the following grids that may be of current use:

1. `12-284` 4 squares per inch.
2. `12-285` 5 squares per inch.
3. `12-286` 6 squares per inch.
4. `12-288` 8 squares per inch.
5. `12-280` 10 squares per inch.
6. `12-282` 20 squares per inch.
7. `12-189` 5 squares per Centimeter.

The original grids were available in a few colors with green, orange and "fade out" blue being common.

Using a search for "national `xxx`" with `xxx` being replaced with any of the above National part numbers will help in identifing current sources for the equivalent grids. National seems to have been absourbed into several companies over the last few decads and does not appear to still exist as an independant company.

Other companies that used to make grids include: K&E (Keuffel & Esser) and Eugene Dietzgen. There are probably many others, but samples from these three companies is all that I have on hand and thus can spell their names correctly. "The internet is your friend" for other sources.

2 The Grids

2.1 Problems using the Grids

When I made my first attempt to closley examine the shape, and count, of some saw teeth I made several errors:

1. I did not always have the camera, my cell phone, the same height from the saw.
2. I did not always have the camera at the same atitude (angle to the saw, etc.)
3. I did not always have the grid positioned at the same place. If any comparisons between pictures of a saw are being made, it is easier if they have as many similar points as practiable.
4. The focus and zoom varied through out the series of pictures.
5. I didn't always use the same place on the grid relative to the picture.

2.2 "Calibration" Marks

Metric grid markings

- I have placed a calibration mark in 4 places on each grid. This is done to ease using the same section of a grid for different resoultion pictres of a saw to be made.
- The 4 calibration marks are all in the same place on all metric grids.
- The calibration marks are 30 mm in from the margin of each metric grid. This is to allow showing some of the saw before/after the mark which is sometimes useful when determining exactly what is being shown in the picture.
- The calibration marks on the lower portion of the grids are placed so that the resoultion of the grid may be included in any photos.
- Along each side of a grid I have placed marks at 10 mm intervals. By checking that these marks they are still at 10 mm intervals, it may be determined if the paper has changed size due to any of various factors.
- On the bottom of each grid I have placed teo sets of inch markings. One reads from left to right and under it there is the second set that reads from right to left.
- On all metric grids there are thick lines every 20 or 10 mm. There are thin line on all the minor positions. (10, 5, 2, and 1 mm)

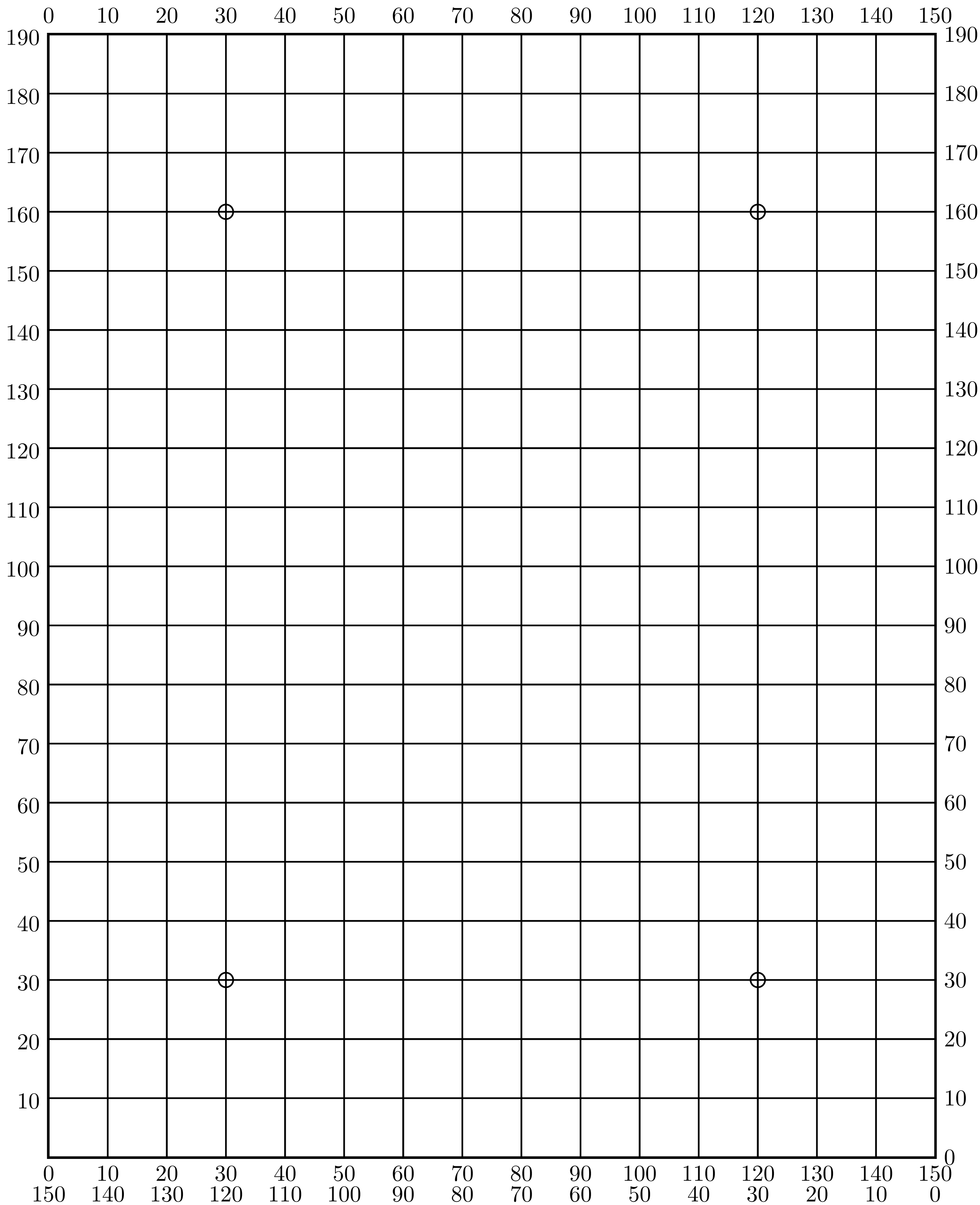

Figure 1: Thick lines 10 mm Grid (10 mm per square) 20 October 2025 0:36

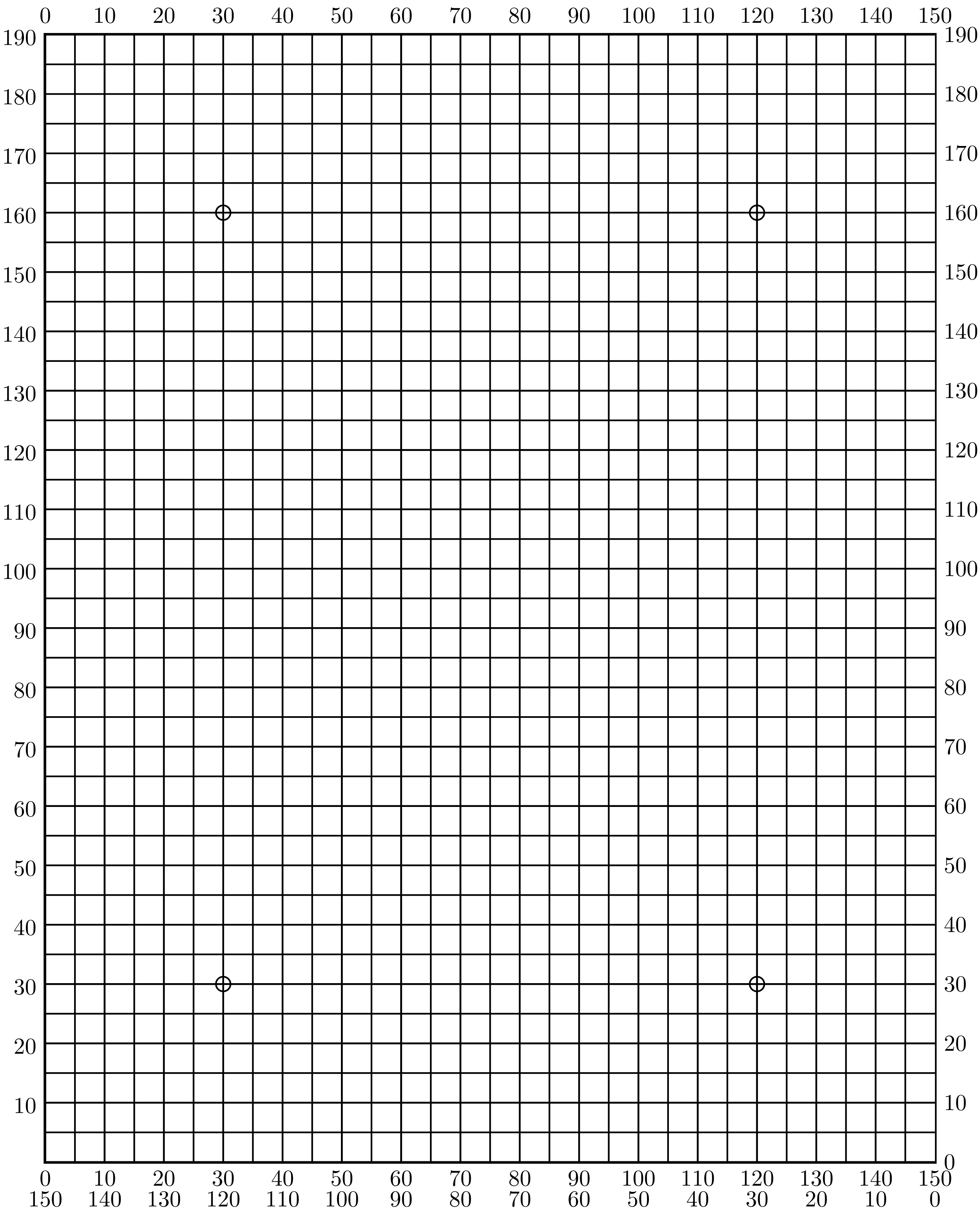

Figure 2: Thick lines 5 mm Grid (5 mm per square) 20 October 2025 0:36

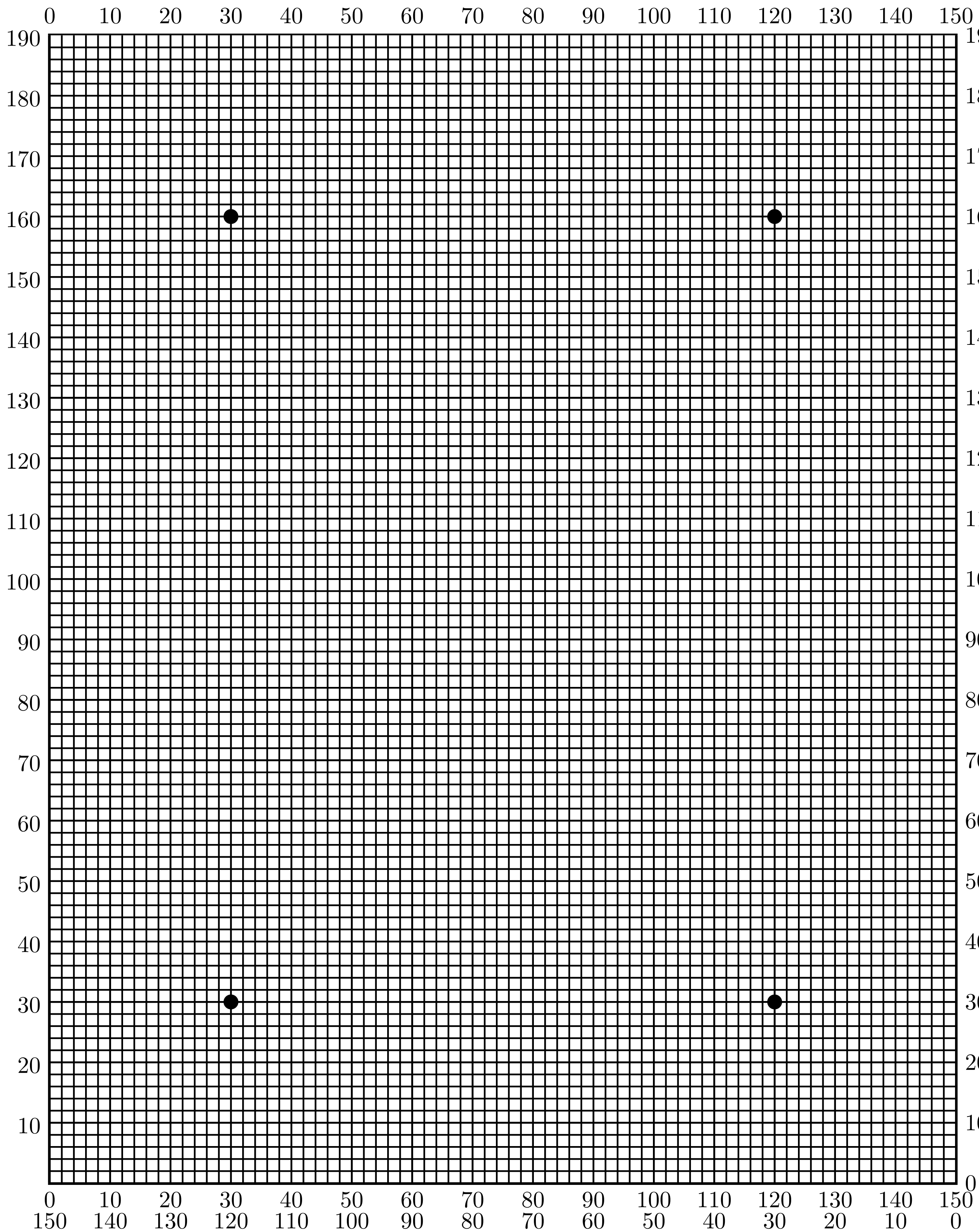

Figure 3: Thick lines 2 mm Grid (2 mm per square) 20 October 2025 0:36

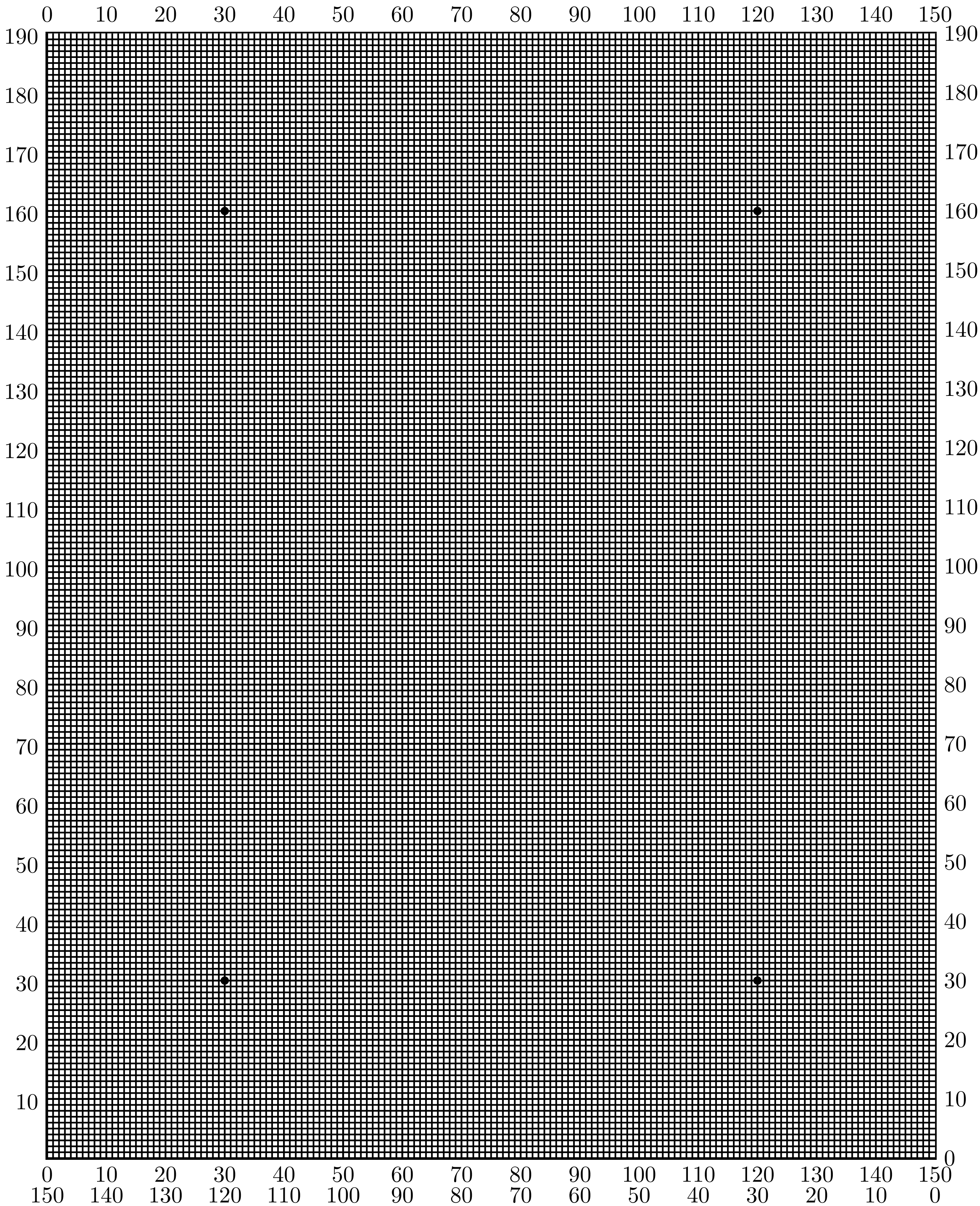

Figure 4: Thick lines 1 mm Grid (1 mm per square) 20 October 2025 0:36