Tour de Force

Wood Turning

Claude LETHIECQ

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Interlude

From square to round
In a matter of months
From cause to effect
From theory to action
A simple block of wood
Becomes a distinct …
Work of Art

John Mallette

Dedication

Had I not read David SPRINGETT's book "Woodturning Wizardry" back in 1993, this book would never have been written. So it is only fair that it is my turn to dedicate this book to him.
But even as I write this I am still not sure if I should be angry or grateful to him for having started this whole adventure.

Acknowledgements

I am particularly thankful to Walter Winninga for all he has done for me throughout the years and to my son Marc for his advice on how to structure this book.

Also, to each and everyone of those that have shared their knowledge and given me advise and comments since my first involvement in woodturning (the list of their names would be too long) I am truly very grateful, thank you all.

Great thanks to my son Jacques for his time and patience building up this book and taking over my outdated hand written work making it available worldwide and free through this wonderful website.

Photo credits

Andi Wolfe (AAW): pages 1, B1, D1, F1, G1, H1, J1, K1
Paul Texier : page 9
Clément Trépanier : pages 35, 37, A1, C1, E1, E9
Jeffrey Greenwood : pages 23, 53
All drawings by Claude Lethiecq
Publishing by Jacques Lethiecq

Foreword

In the Pitti Palace, Florence, Italy, the Green Vault, Dresden, Germany, and scattered in collections around Europe are the finest examples of sixteenth-century ivory tour de force turnery, which had been unsurpassed for centuries. Claude Lethiecq, drawing from his engineering background and using his imagination and skills, has developed this form of turning to an even higher level.

So often craftsmen, who have spent time developing almost magical skills and techniques, are reluctant to pass on their knowledge. In this electronically published book, Claude Lethiecq explains all, which makes this document historically significant. Turners now, and in the future, will benefit from the time he has devoted to documenting in such detail, his tools and methods.

It is remarkable to see the ingenious methods that Claude has developed to hold the work, to see how he brings the required parts on centre enabling them to be worked. Look at the tools he has developed for each specific use which are now so obviously right, but facing the problems he did would we have produced the correct solution?

By making his methods so publicly available, Claude Lethiecq will surely receive the recognition he so fully deserves. Tour de Force Wood Turning is an excellent book, in every respect. Thank you Claude.

David Springett

Foreword

In June of 2010, I had the pleasure of meeting a most fascinating and creative woodturner: Claude Lethiecq. At the time, I was serving on the board of the American Association of Woodturners (AAW) and one of my duties during the Hartford AAW Symposium was to organize and oversee the Instant Gallery – an exhibition of more than 1500 pieces of attendee work. At that event, Claude displayed many of the incredible woodturnings that he profiles in this book. To say that Claude's work attracted attention would be a huge understatement. I observed as he spent most of his weekend trying to explain his techniques to other attendees.

During my limited time with Claude, it became apparent that he had taken the art of turning "Chinese Balls" to a much higher level. When you first view Claude's work, it simply boggles the mind. How did he do that? How did he turn such intricate components inside other intricate components? And he does it with such precision. How does he do it all from a single piece of wood with no deconstruction/reconstruction? The "how to" mysteries are all explained in the following pages. He not only shows how to accomplish "the impossible", but he shares how to make the very special tools that make it possible.

If you like a challenge, if you enjoy solving puzzles, if you are looking for something to take your own woodturning to a higher level, then I encourage you to spend some time exploring Claude's techniques.

Woodturners are very "sharing" and Claude is no exception. Not only has he taken many months to write this wonderful resource; he has made it available at no cost to the whole woodturning community – what a generous and valuable contribution to the world of wood art.

Thank you Claude,

Malcolm Tibbetts

Content

Projects

A - *Chinese Ball*

B - *Spiked Dodecahedron in 3 concentric spheres*

C - *Spiked Dodecahedron in 2 concentric spheres in a dodecahedron*

D - *Supernova*

E - *Cyclope*

F - *Baker's Dozen*

G - *Implosion*

H - *Surprise*

J - *Genesis*

K - *Mysterium Cosmographicum*

Introduction

Historians and woodturning amateurs have published numerous well documented works on the history of this ancient art. So I will save you the pain of adding my 2 pennies worth.

The present work is mostly for those woodturners who have a minimum experience with a lathe and I hope will incite many to get started or improve on the pursuit of this fascinating branch of woodturning.

In a practical way, this book is a copy of my shop notes and drawings plus details pertaining to the design, calculation, cross-sections, tools, jigs and my method of making a piece of "Tour de Force" woodturning.

Fully understanding a paragraph before going to the next one is a must.

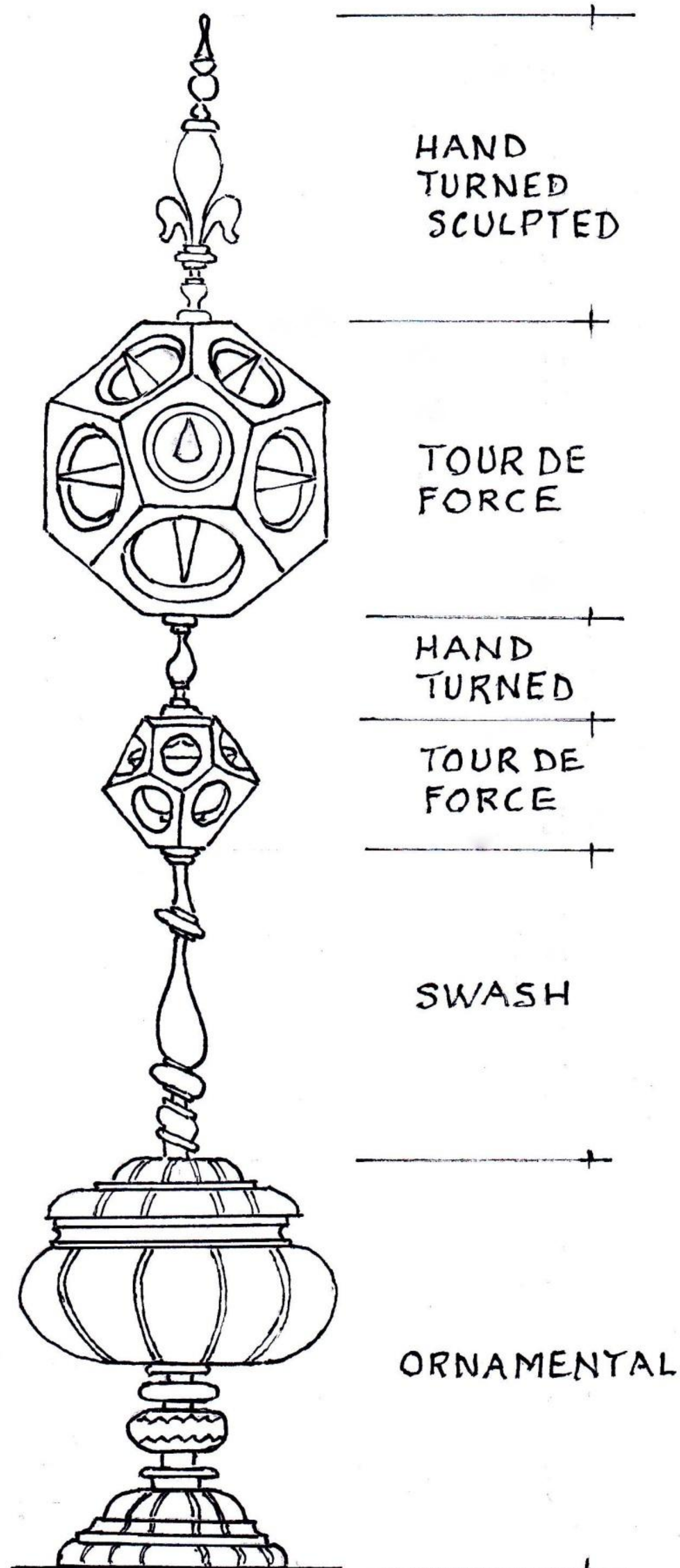
Also, whether I use the right word or not to describe something, it would be better that you accept that word so that we speak the same language.

I would appreciate comments and being informed of any errors or omissions.

"Tour de Force" Definition

Please let's settle this once and for all "Tour de Force" IS NOT "Ornamental" although a piece of "Tour de Force" is sometimes incorporated in an ornamental piece done on a "Rose Engine".
So "Tour de Force" is to turn the most inside a solid piece of wood from the smallest openings, nothing added, all on the lathe!

As for "Chinese Ball" (Boule de Canton) it is probably the most ancient and easy piece to do. First done in Europe (or maybe not?) and later taken up by the Chinese whose biggest merit was the exceptional sculpting of these pieces, hence the name "Chinese Ball". I said easy, except the 22 concentric spheres by Paul TEXIER (dia. 162 mm), certainly a world record (to my knowledge anyway)!



DE: L'ART DE
TOURNER EN
PERFECTION
PLUMIER 1749
PLANCHE LXII.

Dimensions

All dimensions are in millimeters.
For example : 183.0

To get inches : divide mm by 25.4
Ex : 183.0 mm ÷ 25.4 = 7.205 ''

To get mm : multiply inches by 25,4
Ex : 7.205” x 25.4 = 183.0 mm

- NEVER USE FRACTIONS ! -

Wood Used

Any close grain, slow growth hard wood can do, but the best are first BOXWOOD (Buxus Sempervirens) but it is very rare in decent sizes. Next would be COSTELLOW (Gossypiospernum) very close to the real thing and comes in big sizes but hard to find in my part of the woods.

I have also successfully used BLACK WALNUT (Juglansregia), SUGAR MAPLE (Acer Saccharum), BLACK CHERRY (Prunus Serotina) and YELLOW BIRCH (Betula Alleghaniensis) for some pieces of “Tour de Force” turnings.

Wood Deformation

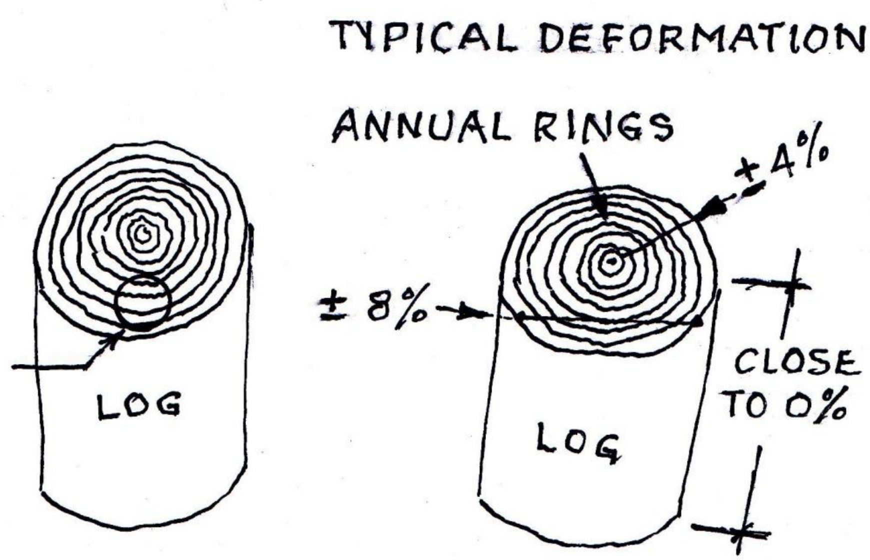
How often have you heard " this piece of wood is bone dry, it's from a barn that was 100 years old" … but beware, regardless how old it is, wood that takes humidity will swell and if it loses humidity it will shrink and crack, even if it swells again, the cracks will not be visible but will still be there.

Wood deforms differently in 3 directions and varies with the humidity and the type of wood.

Turn a sphere to exact size, let it stand on the work bench and re-measure it on 3 axis a day or two later and you will be surprised (3 different measures).

I once have had a turning, half way done that cracked on the lathe for no apparent reason; I can only guess that as you turn wood away, internal stresses are relieved.

If a turning blank is taken off center, the annual rings tend to flatten, thus creating an elliptical shape instead of a true sphere



Wood Stabilizer

This chapter will certainly sound like a publicity pitch and that is okay for me, because this product has worked admirably well with green or dry wood.

This product is called “PENTACRYL” and is sold by “Lee Valley Tools Ltd”.

Made from siliconized polymers (whatever that means), the viscous liquid migrates into the green or wet wood and stabilizes the cellular structure by displacing its moisture.

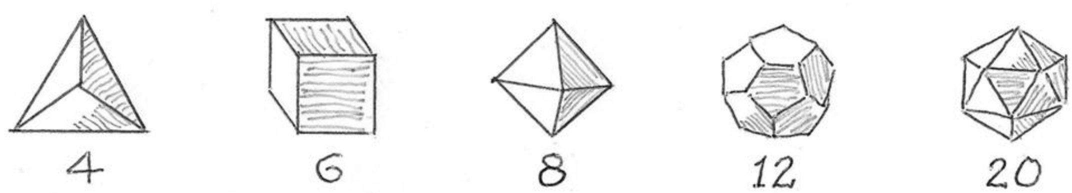
First I treat the turning blank as much as possible and once on the lathe (sometimes for many days) whether I stop for lunch, coffee break or for the night I would splash that stuff and cover the piece with a plastic bag. Also once in a while on a flesh cut.

Dry wood should be wetted before for a good absorption of the stabilizer.

Polyhedrons (Platonic Solids)

A polyhedron is a solid piece with multiple facets but there are only 5 perfect ones :

- Tetrahedron with 4 facets
- Hexahedron with 6 facets (the cube)
- Octahedron with 8 facets
- Dodecahedron with 12 facets
- Icosahedron with 20 facets



The 4 conditions for a perfect polyhedron are :

1. all faces have the same shape
2. all faces have the same size
3. all sides are of equal length
4. all angles are the same

You could also have a 14 facets polyhedron (6+8) called Cub-octahedron or a 32 facets (12+20) called Icosidodecahedron but they would not qualify for a perfect polyhedron. The 32 facets one is exactly the soccer ball.

All "Tour de Force" turnings in this book are based on the perfect polyhedrons mentioned above.

Euler's formula for the 5 perfect polyhedrons is : Faces + Summits = Ridges +2

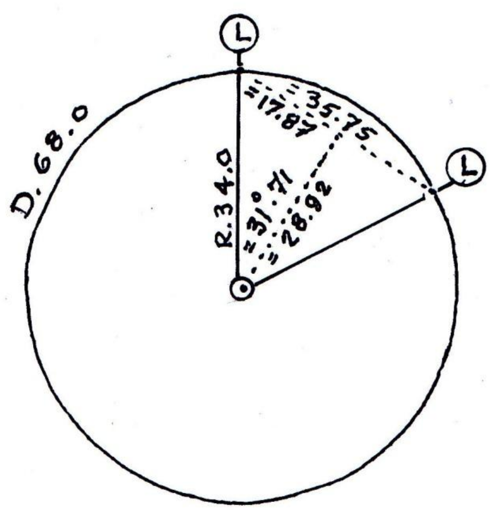
Calculation Chart

In this book all turnings are made from a solid sphere, so its surface has to be divided into equal parts and this can only be done in 4, 6, 8, 12 or 20 parts which corresponds to the number of faces of the 5 perfect polyhedrons shown in the chart.

So I worked out a chart where the surface of any size sphere could be divided into the number of faces of each 5 perfect polyhedrons by simple multiplication.

For example : should you want to make a “Chinese ball” with 12 openings or a polyhedron with 12 facets (dodecahedron), the markings on the surface of the sphere would be the same. These marks I call L are the center of each opening or the projection of the center of each face of the dodecahedron on the surface of the sphere.

Here is an interesting little calculation while working out my chart.



Dodecahedron Division

L-L = D 68.0 x 0.5257 = 35.75
35.75 ÷ 2 = 17.87
17.87 ÷ R 34.0 = sin 31°715
R 34.0 x cos 31°715 = 28.92

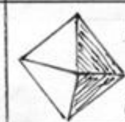
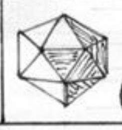
28.92 ÷ 17.87 = **1.618**

GOLDEN NUMBER !

— CALCULATION CHART — C.LETHIECQ

TO DIVIDE THE SURFACE OF A SPHERE IN 4, 6, 8, 12 OR 20 EQUAL PARTS

FACTORS TO X BY THE DIA. OF THE SPHERE

L-L	½L-L	L-S	S-S	½S-S	A	B	C	POLYHEDRON
.8165	.4597	.5774	.8165	.4597	.2357	.4714	.3334	 TETRA-HEDRON (4 FACES)
.7071	.3827	.4597	.5774	.3029	.2887	.4083	.2113	 HEXA-HEDRON (6 FACES)
.5774	.3029	.4597	.7071	.3827	.2041	.4082	.2113	 OCTA-HEDRON (8 FACES)
.5257	.2759	.3204	.3568	.1814	.2486	.3035	.1027	 DODECA-HEDRON (12 FACES)
.3568	.1814	.3204	.5257	.2759	.1518	.3035	.1027	 ICOSA-HEDRON (20 FACES)

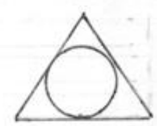
L = PROJECTION AT THE SURFACE OF A SPHERE OF THE CENTER OF A FACE OF A POLYHEDRON.

S = COMMON SUMMIT AT THE SURFACE OF A SPHERE OF ADJACENT FACES OF A POLYHEDRON.

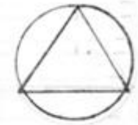
C = "L" AND THE CENTER OF A FACE OF A POLYHEDRON. DISTANCE BETWEEN POINT

L-L, L-S OR S-S = DISTANCE BETWEEN THESE POINTS IN A VERTEX (STRAIT LINE).

A = MAX. RAD. OF A CIRCLE INSIDE A FACE OF A POLYHEDRON.



B = MIN. RAD. OF A CIRCLE OUTSIDE A FACE OF A POLYHEDRON.



FOR 6+8 FACES "CUBOCTAHEDRON" USE "S" ALSO AS "L" OF THE EXAHEDRON, SAME FOR 12+20 "ICOSIDODECAHEDRON" WITH THE DODECAHEDRON.

General Information

It is preferable to turn rather fast and to feed the tool slowly to reduce the stress on the wood,

Do all the possible sanding directly on the rotating piece,

Often use wood stabilizer,

Cover the piece with a plastic bag for the night,

Do not put excessive pressure on the chuck ring. The further you go the more delicate the turning becomes,

Plugs are made undersize, well covered with partly melted wax, pushed in where they belong (work fast, the wax hardens in no time), put enough wax so it will splurge between the shells.

The small spikes are proned to braking since no matter how many there are, only two are on the end grain, all others are cross grain. So as soon as one is turned and before sanding, use low viscosity cyanoacrylate glue to more or less saturate the wood, it worked well for me anyway! For bigger spikes I drill a hole and set a steel rod (finishing nail with no head) and let it stick out about 3 mm to hold a finial later.

◎ = indicate the central point of a sphere or circle. Other pivot points are marked ⦿

Do not take any measures from the drawings, all dimensions are indicated.

No matter what exterior shape the piece I want to make, I always start with a solid sphere and finish with a solid sphere, hence the reason for the “CAP” (details with each piece that needs it). That way, the spherical chuck works well and it is easy to rotate a turning and index it to another point.

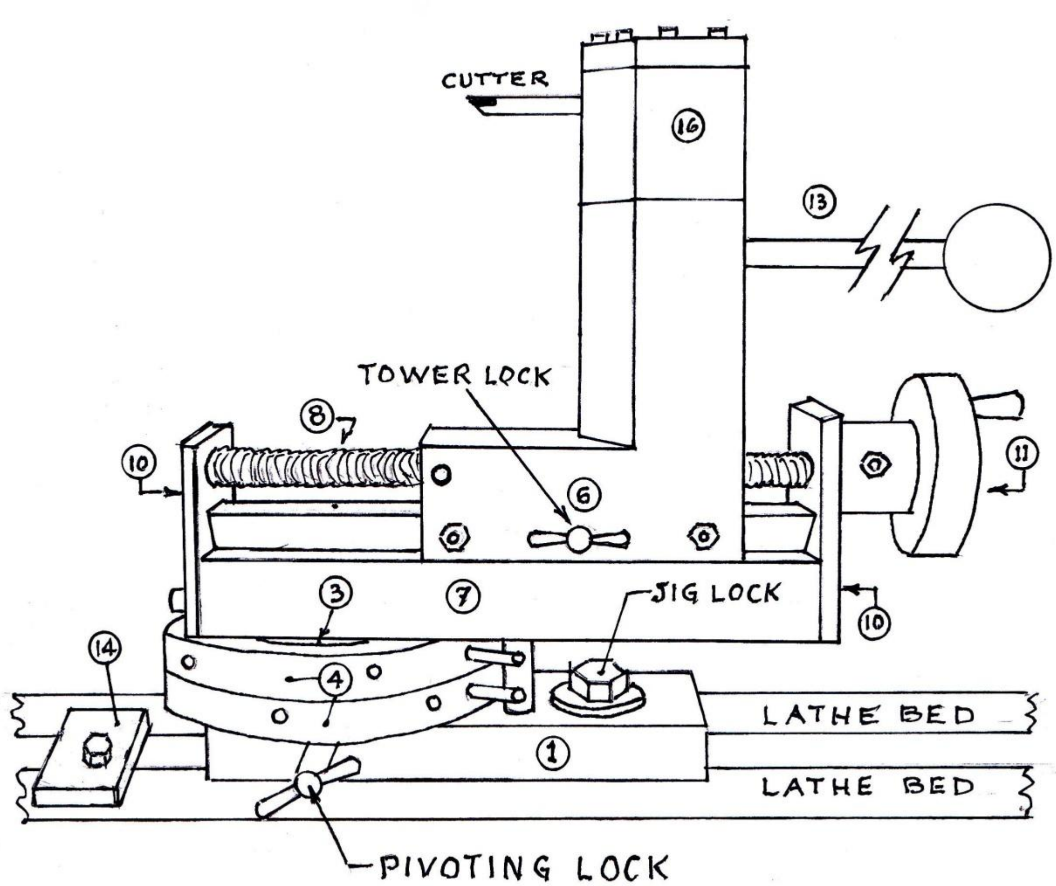
Once you start working on a piece, it is imperative that you do all that has to be done in that opening; otherwise you would never be able to re-index that piece in the exact same position.

Jigs & Tools

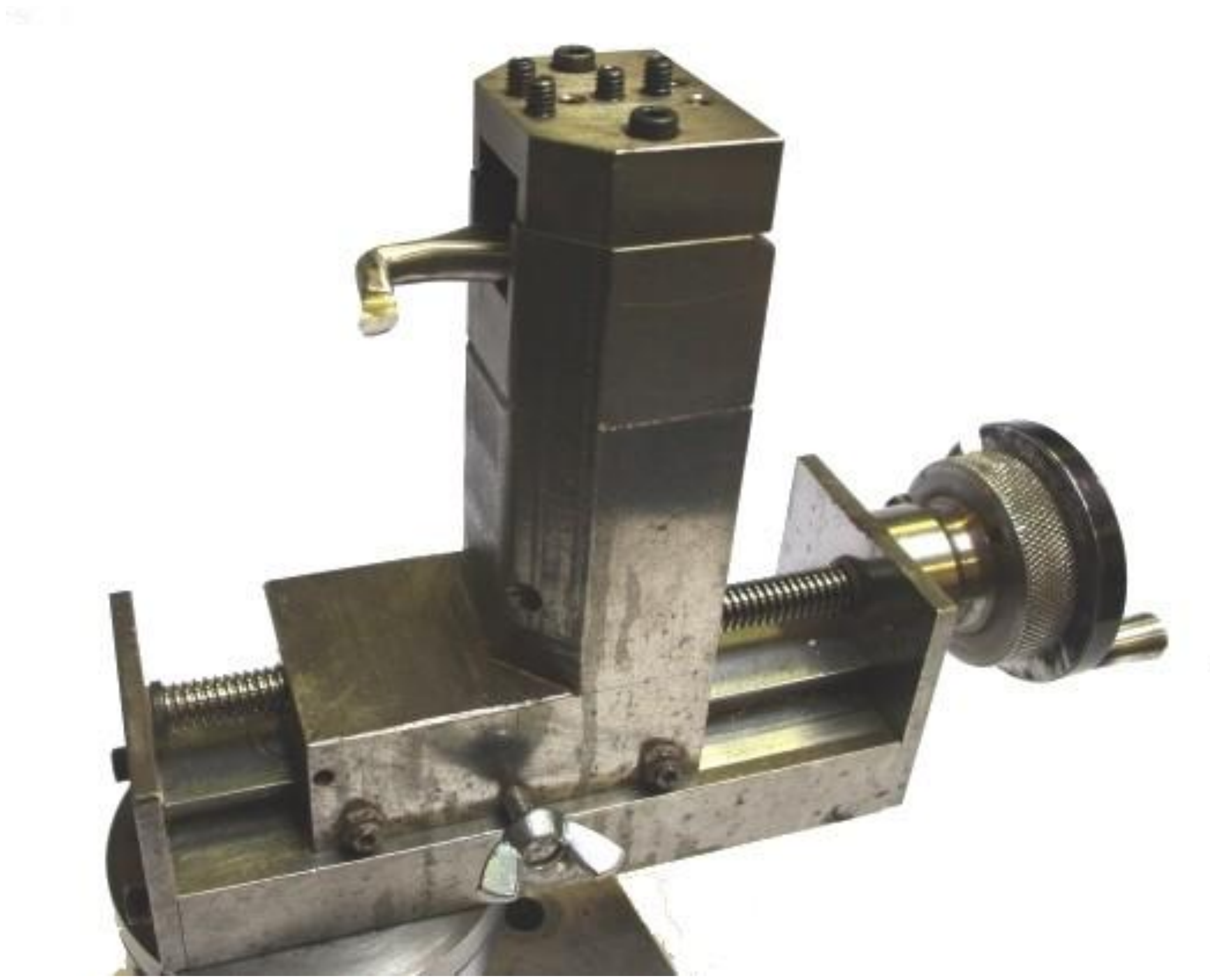
Sphere jig

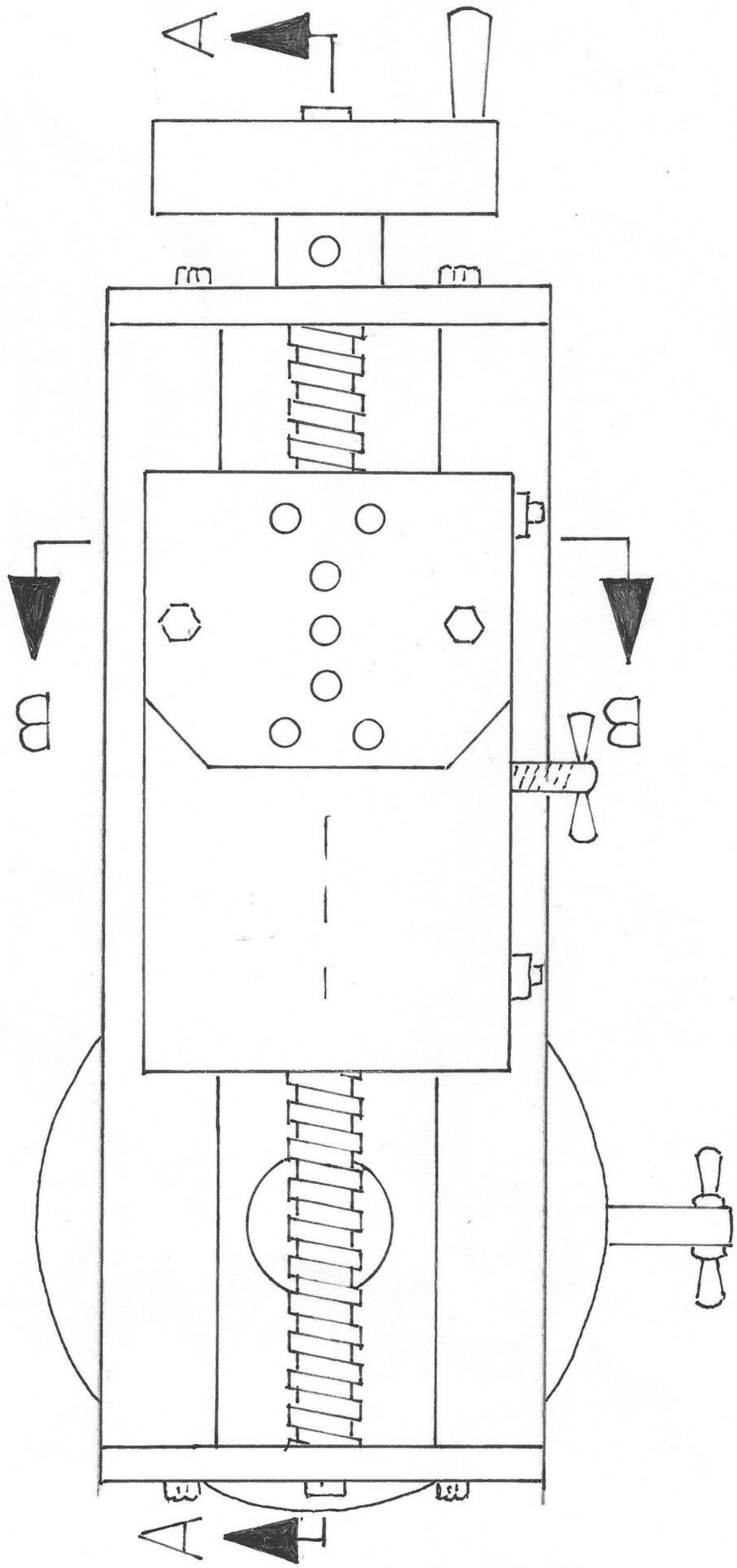
This jig is used to turn solid spheres, spherical chucks and all of my “tour de Force” turnings.

I strongly suggest you make a rough full size wooden mock-up where the appropriate parts move or pivot. Just dowel for the screw.

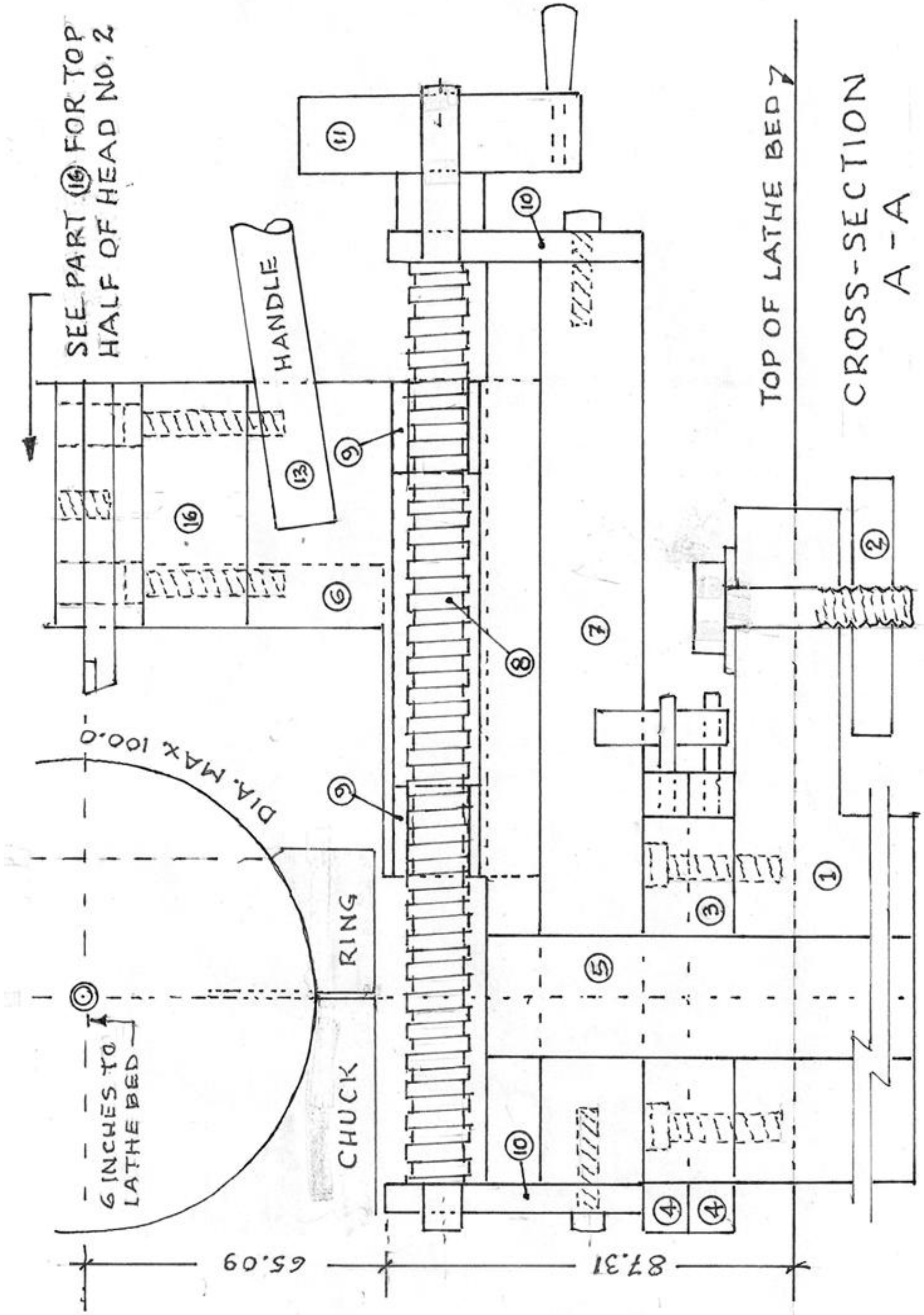


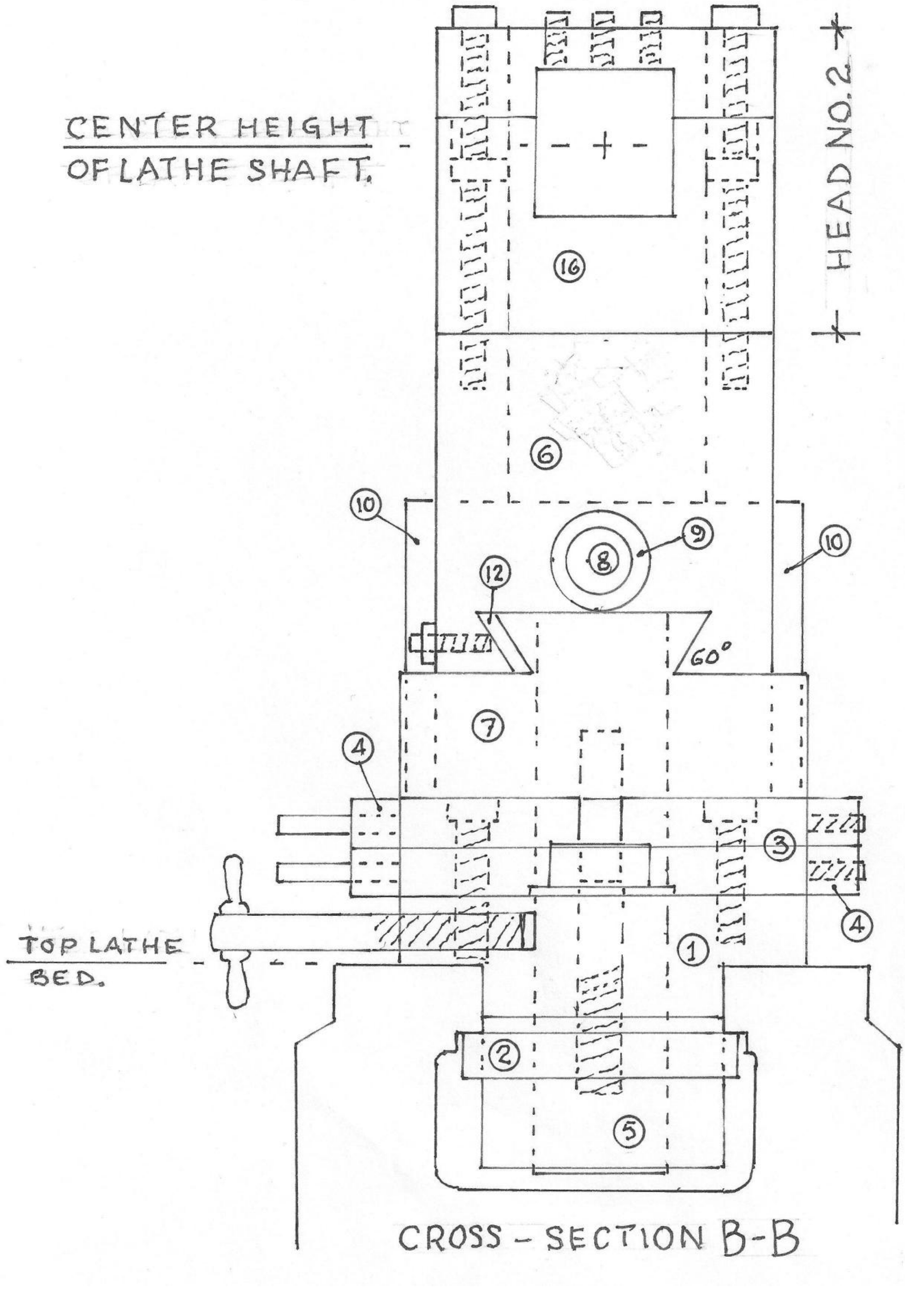
1 - Base on lathe bed 2 - Lock plate 3 - Disk 4 - Free turning rings 5 - Pivoting shaft 6 - Tower 7 - Tower base 8 - Treaded rod 9 – Sleeve x 2	10 – End plate x 2 11 – Hand wheel 12 - Key 13 - Handle 14 - Stopper 15 – Head N°1 16 – Head N°2 17 – Head N°3





TOP VIEW OF SPHERE JIG
CROSS-SECTION A-A AND B-B


SEE PART 16 FOR TOP
HALF OF HEAD No. 2
HANDLE
TOP OF LATHE BED
CROSS-SECTION
A-A
DIA. MAX. 100.0
RING
CHUCK
6 INCHES TO
LATHE BED
65.09
87.31



CROSS - SECTION B-B

Features of the sphere Jig

1. This jig has done everything for every turning in this book and all the features have been used.
2. This jig can be moved anywhere on the lathe bed and locked in place.
3. The pivoting point, set where needed and reset at the same place using a “stopper”.
4. The tower can be moved forward or backward via a very accurate threaded rod.
5. The tower can be pivoted right or left and with an integrated stopper the angle can be repeated exactly.
6. With the pivoting tower it can become a double cross-slide at any angle.

Notes on the sphere jig dimensions

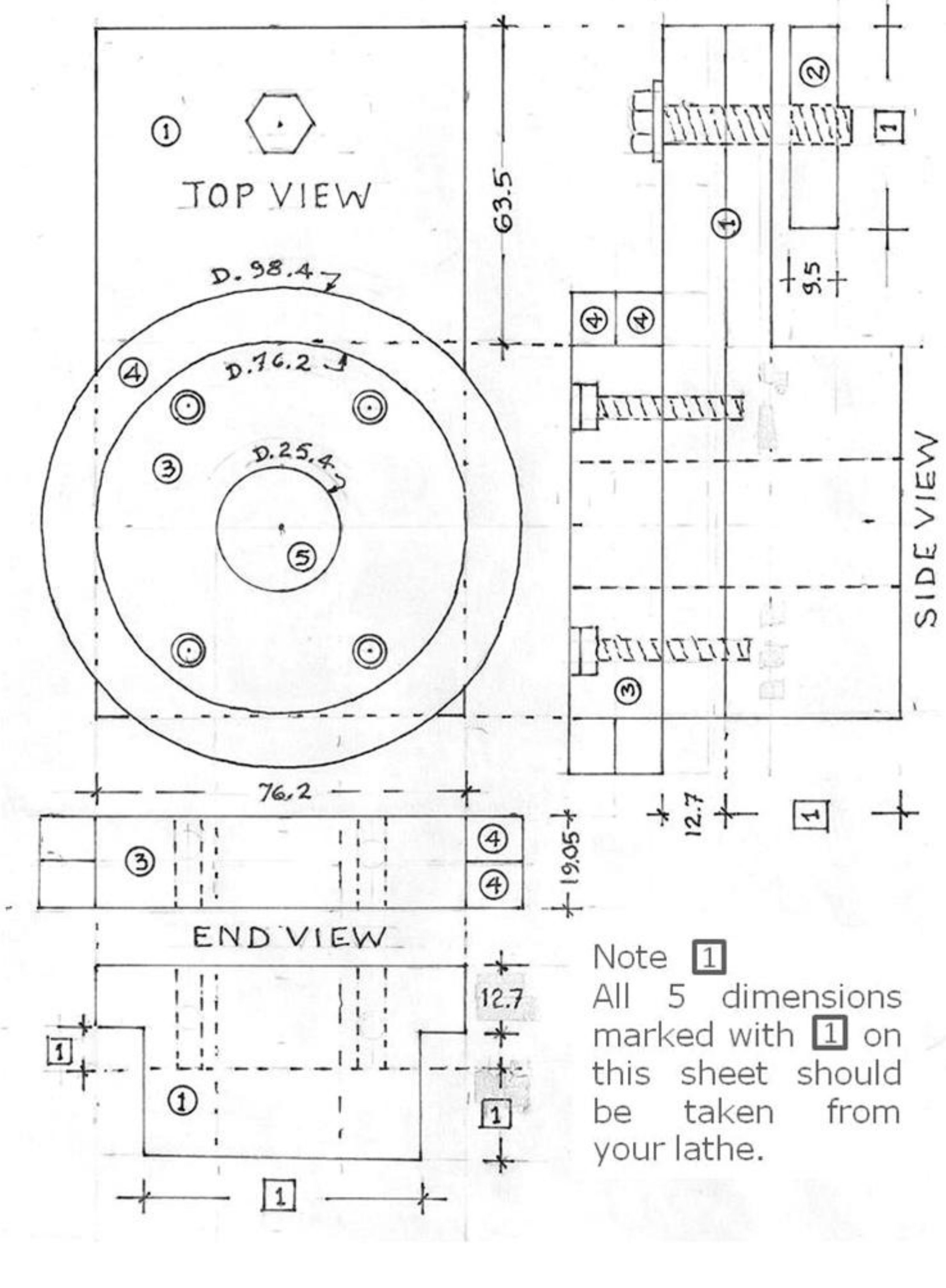
The dimensions of the sphere jig on the following pages are for a 12 inches swing lathe (152.4 mm center height) permitting to turn a sphere of a maximum diameter of 100 mm. For a bigger lathe only a few dimensions have to be changed :

- For a center height of your lathe if more than 152.4 (6”) and up to a maximum of 203.2 mm (8”) : Take the center height of your lathe minus 152.4 mm and add this distance to the 30.14 mm quotation on part N°6 (see next pages). This will enable you to turn a sphere of a maximum of 100 mm plus twice the added distance. You should also add 15 mm to the 96.84 and 190.5 quotations on part 7 (see next pages).

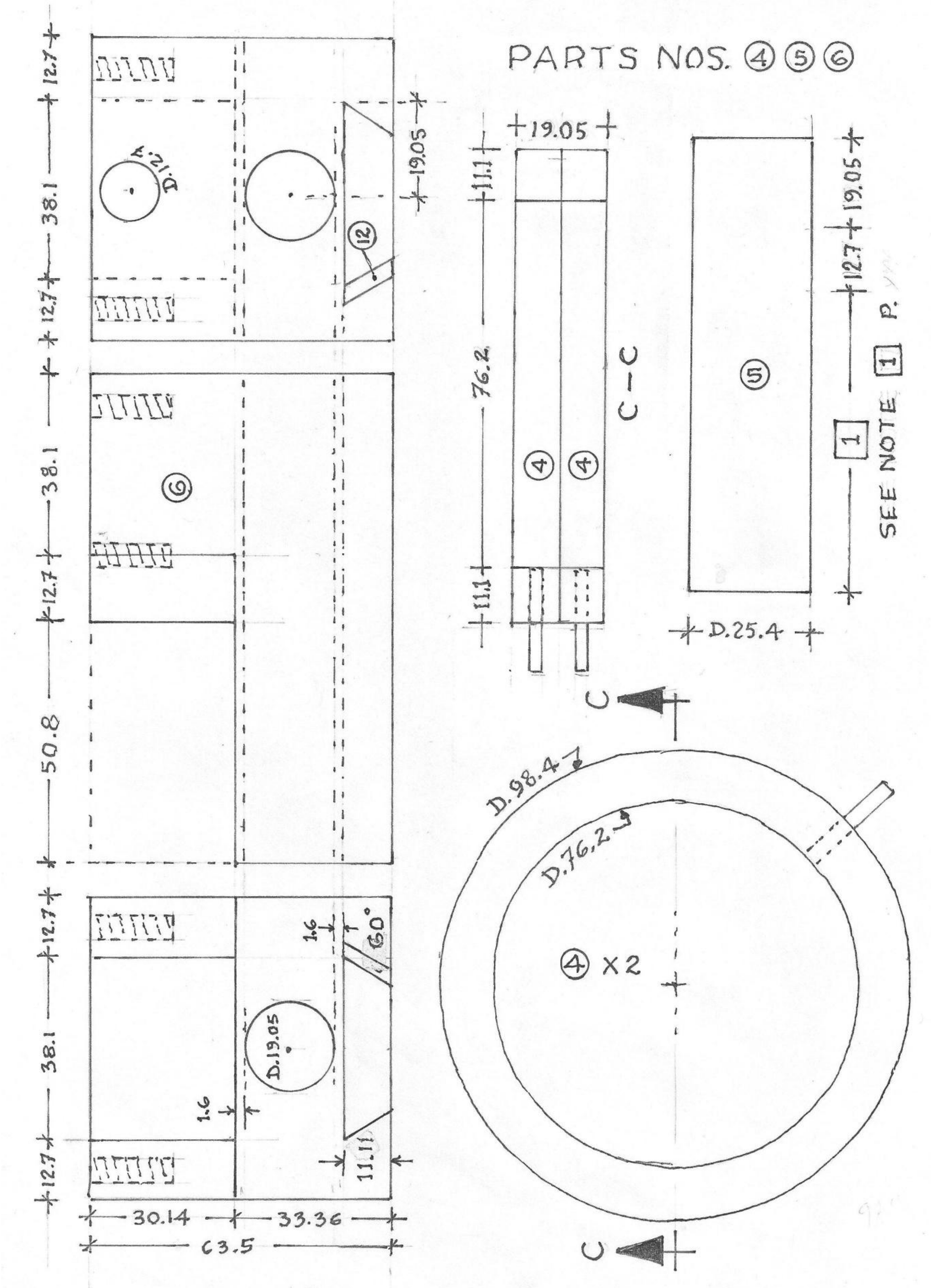
- For a center height of your lathe of up to a maximum of 254.0 (10”): Take the center height of your lathe minus 152.4 mm and add this distance to the 30.14 mm quotation on part N°6 (see next pages). This will enable you to turn a sphere of a maximum of 100 mm plus twice the added distance. You should also add 30 mm to the 96.84 and 190.5 quotations on part 7 (see next pages).

- For a lathe of a center height of 304.8 (12”) all sizes should be increased for a more sturdy and vibration free jig.

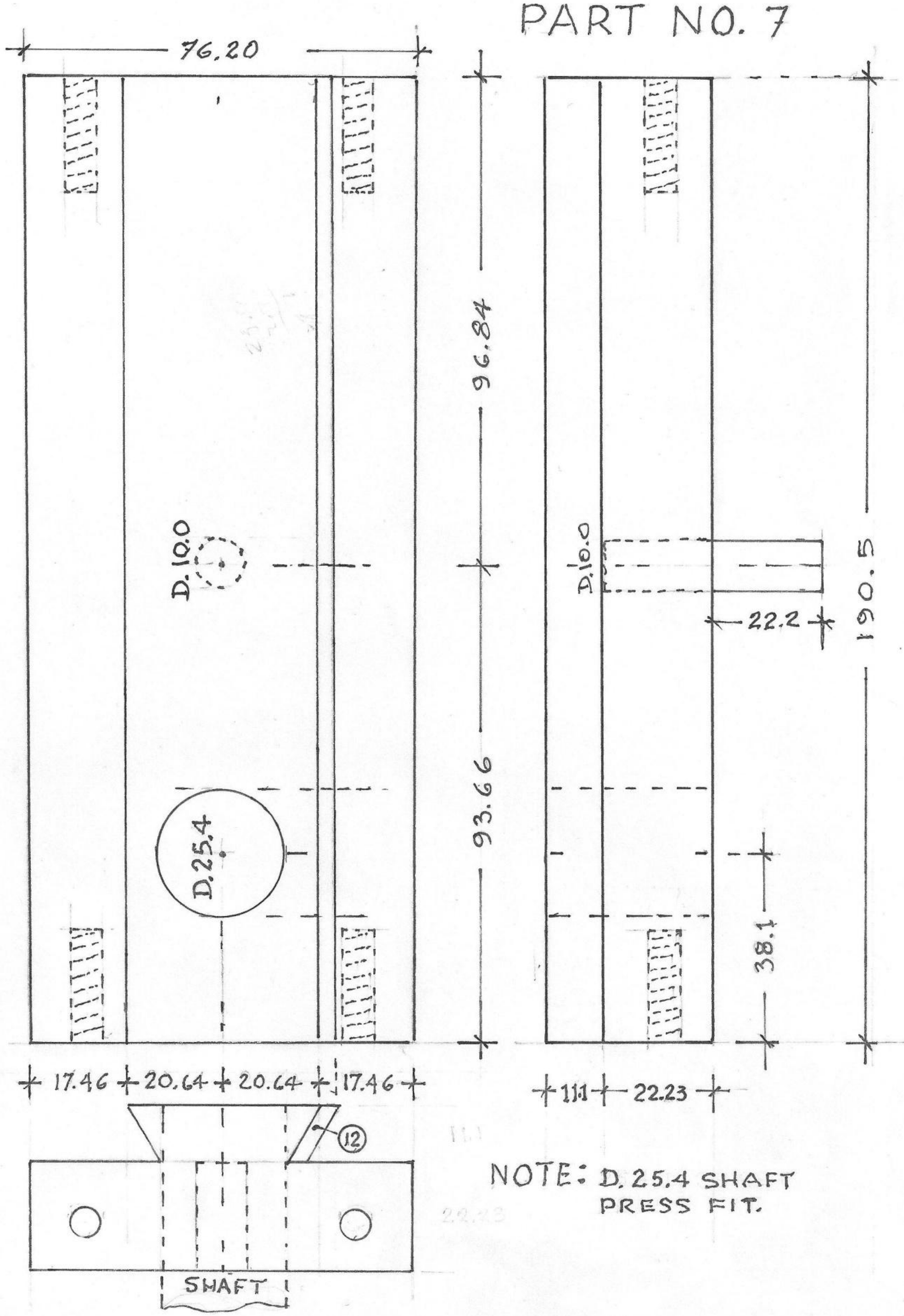
PARTS NOS. ① ② ③



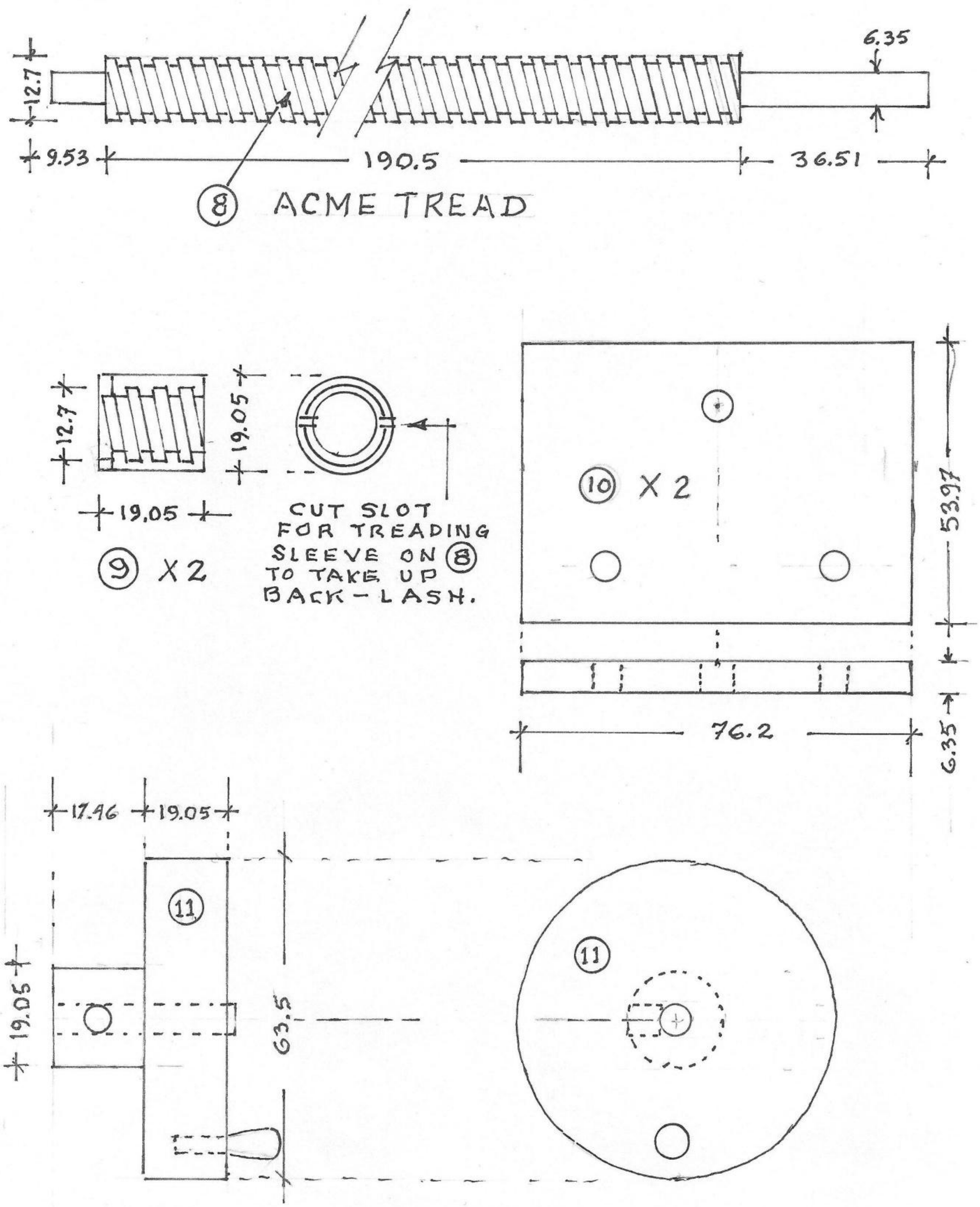
Note [1]
All 5 dimensions marked with [1] on this sheet should be taken from your lathe.


PARTS NOS. ④⑤⑥
19.05
11.1
76.2
11.1
④
④
C – C
⑤
12.7
19.05
SEE NOTE 1 P. 1
D.25.4
C
C
D.98.4
D.76.2
④ X2
12.7
38.1
12.7
D.12.7
19.05
⑫
⑥
50.8
1.6
60°
D.19.05
1.6
11.11
30.14
33.36
63.5

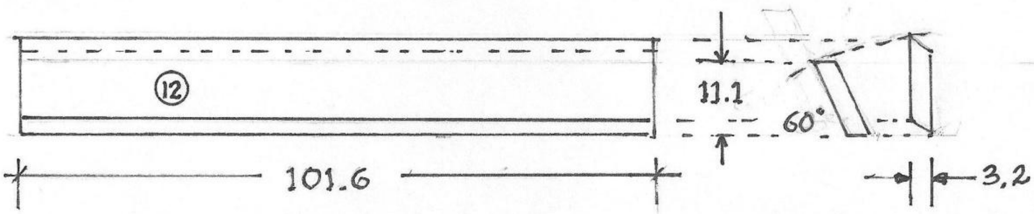
PART NO. 7

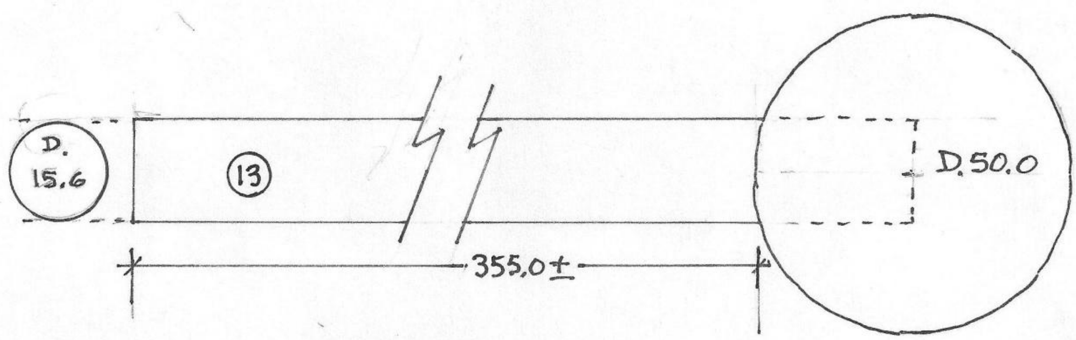

76.20
96.84
93.66
190.5
D. 10.0
D. 25.4
D.10.0
22.2
38.1
17.46
20.64
20.64
17.46
11.1
22.23
12
SHAFT
NOTE: D. 25.4 SHAFT PRESS FIT.

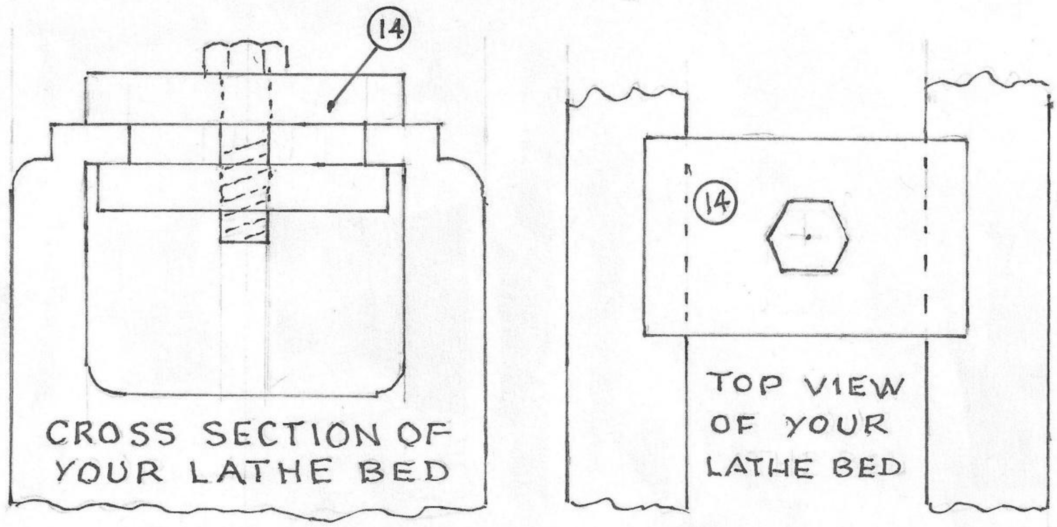
PARTS NOS. 8 9 10 11



PARTS NOS. (12) (13) (14)

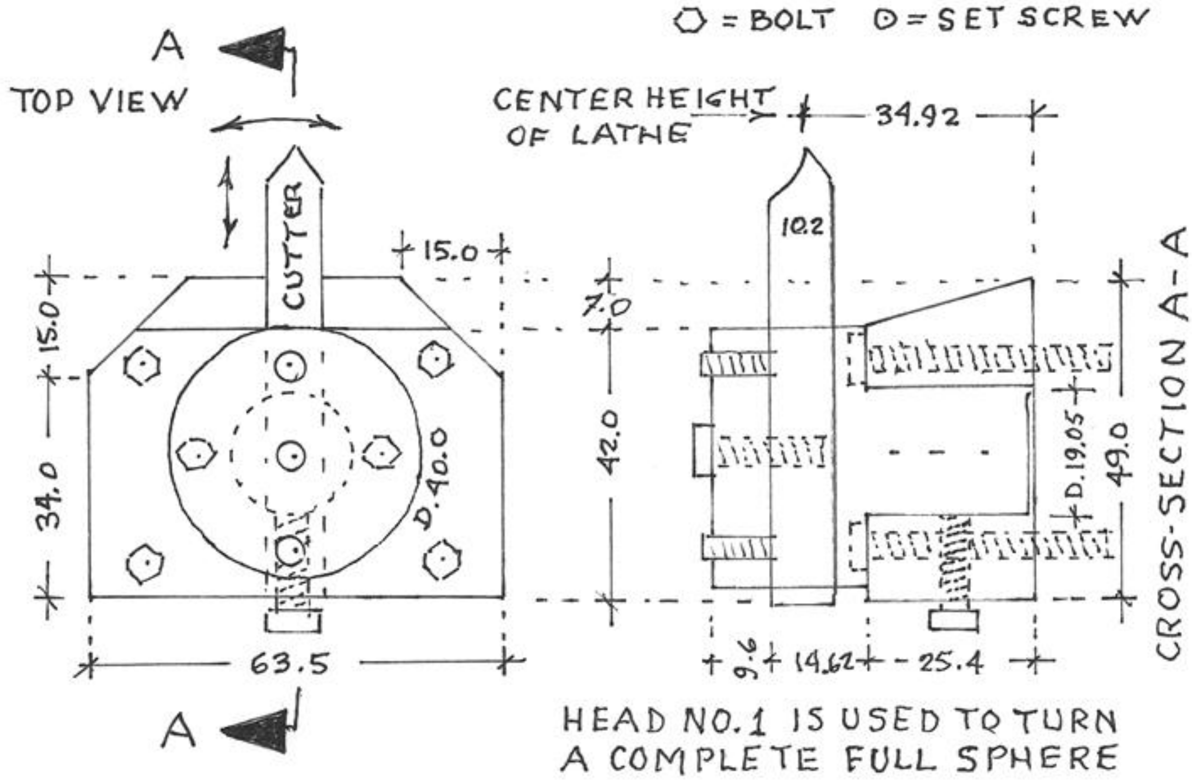




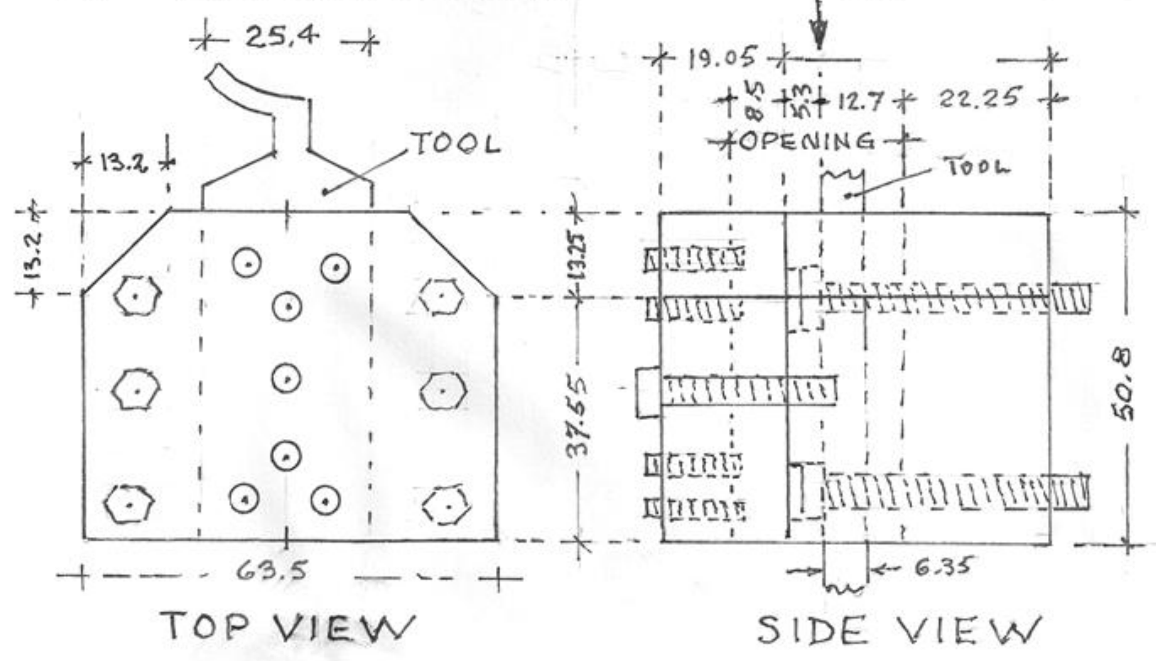


ITEM (14) "STOPPER" TO BE SET AGAINST RIGHT OR LEFT SIDE OF THE SPHERE JIG TO ALLOW THE RE-SETTING OF THE JIG AT THE SAME PLACE IF IT HAD TO BE MOVED.

PART NO. 15 (HEAD NO. 1)

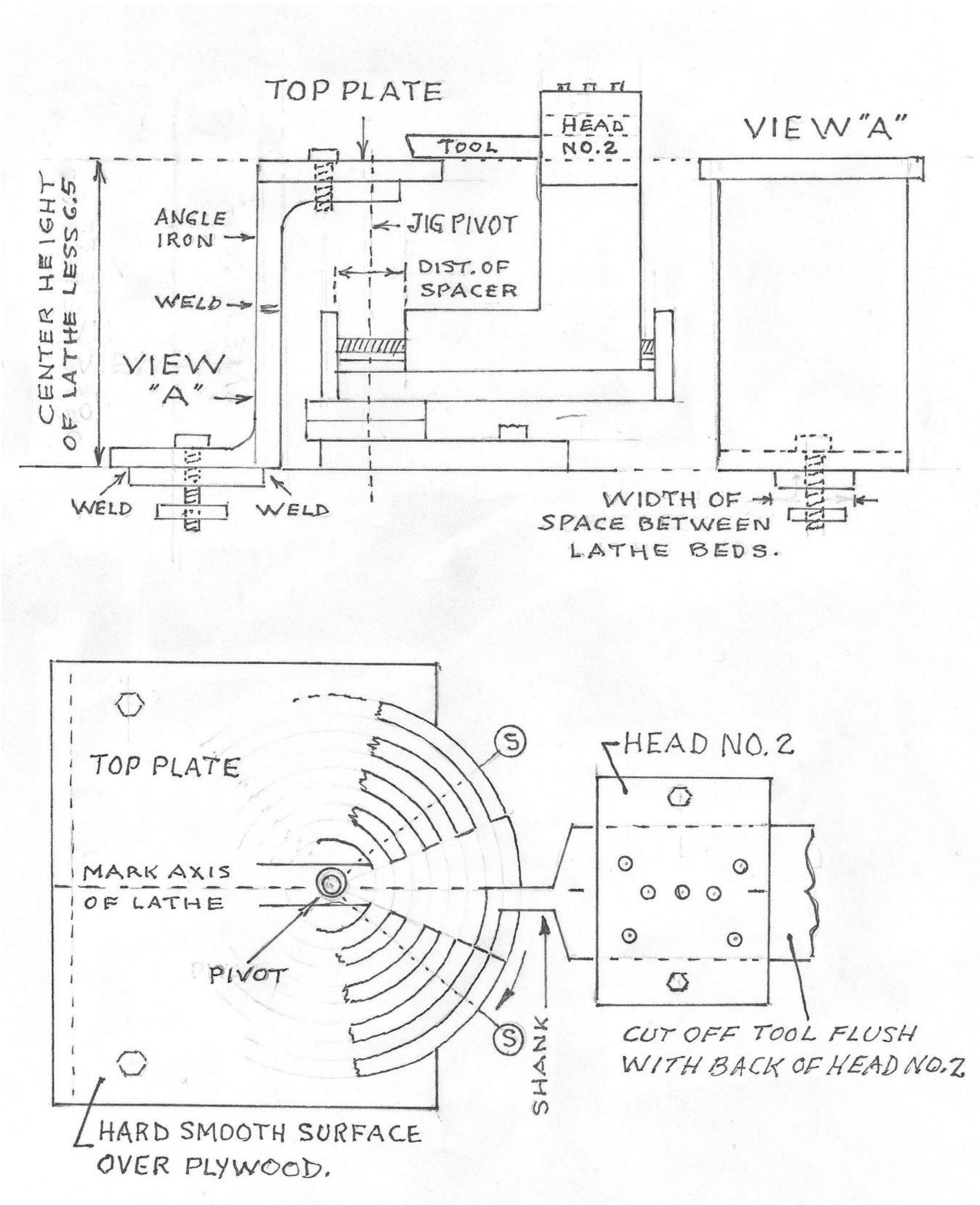


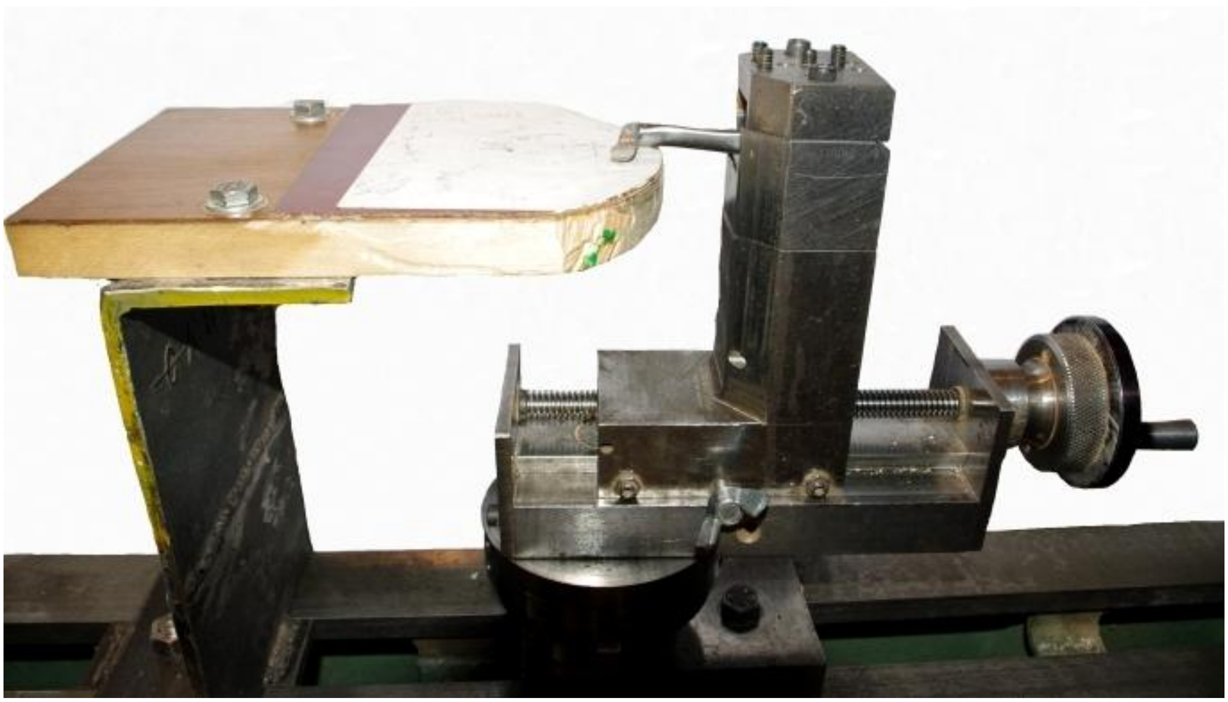
PART NO. 16 (HEAD NO. 2)
USED TO TURN INSIDE SPHERE



Part N°17
Head N°3 (turret)

Simulator Plate (Schematic)





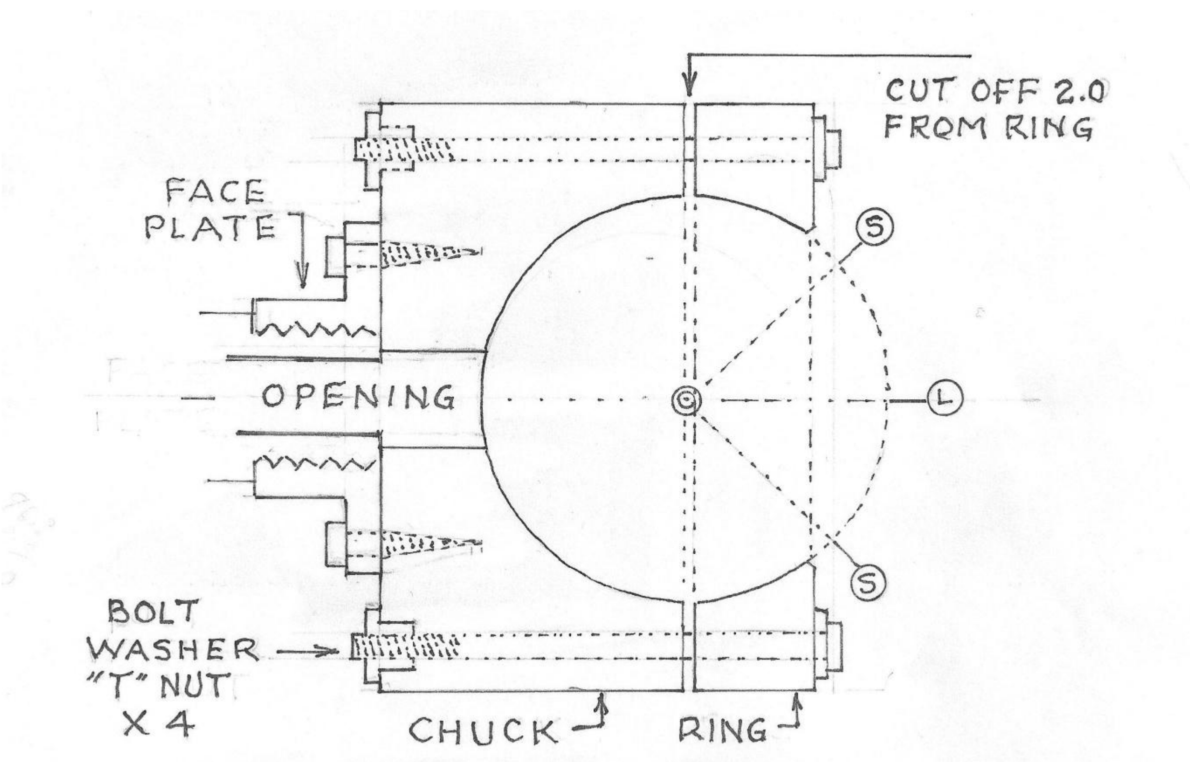
Notes on the simulator plate

- As you turn inside a sphere you do not see what the tool is cutting so this simulator plate permits to see what it will do and gives a chance to refine the shape of the tool.
- Set the plate on the lathe bed, glue a sheet of self adhesive paper and draw a line of the axis of the lathe then draw a cross-section of the piece you want to make as exactly as you can.
- Set the sphere jig pivot in line with the edge of the top plate, set a stopper against the right side of the sphere jig base, then move the jig to the left by a distance of the radius of your cross-section so that the jig pivot is in line with the center ⦿ of your drawing.
- Bring the jig tower reasonably close to the front of the plate, measure the distance of a spacer, make and set one to lock the tower advance (forward or backward).
- Place a tool in head N°2 with a shim of the proper thickness to have the cutting edge of the tool at 12.7 mm and another shim of about 12.7 mm below the tool and lock with sets crews. If needed, take off the tool and reshape it and place it back in head N°2, then mark and cut off the part of the tool that is sticking out at the back of head N°2. This way you can replace the tool exactly at the same place for each of the openings. Repeat for each other tools.
- In most cases the edge of the shank of the tool will act as a travel limit of the tool.

Semi-spherical Chuck

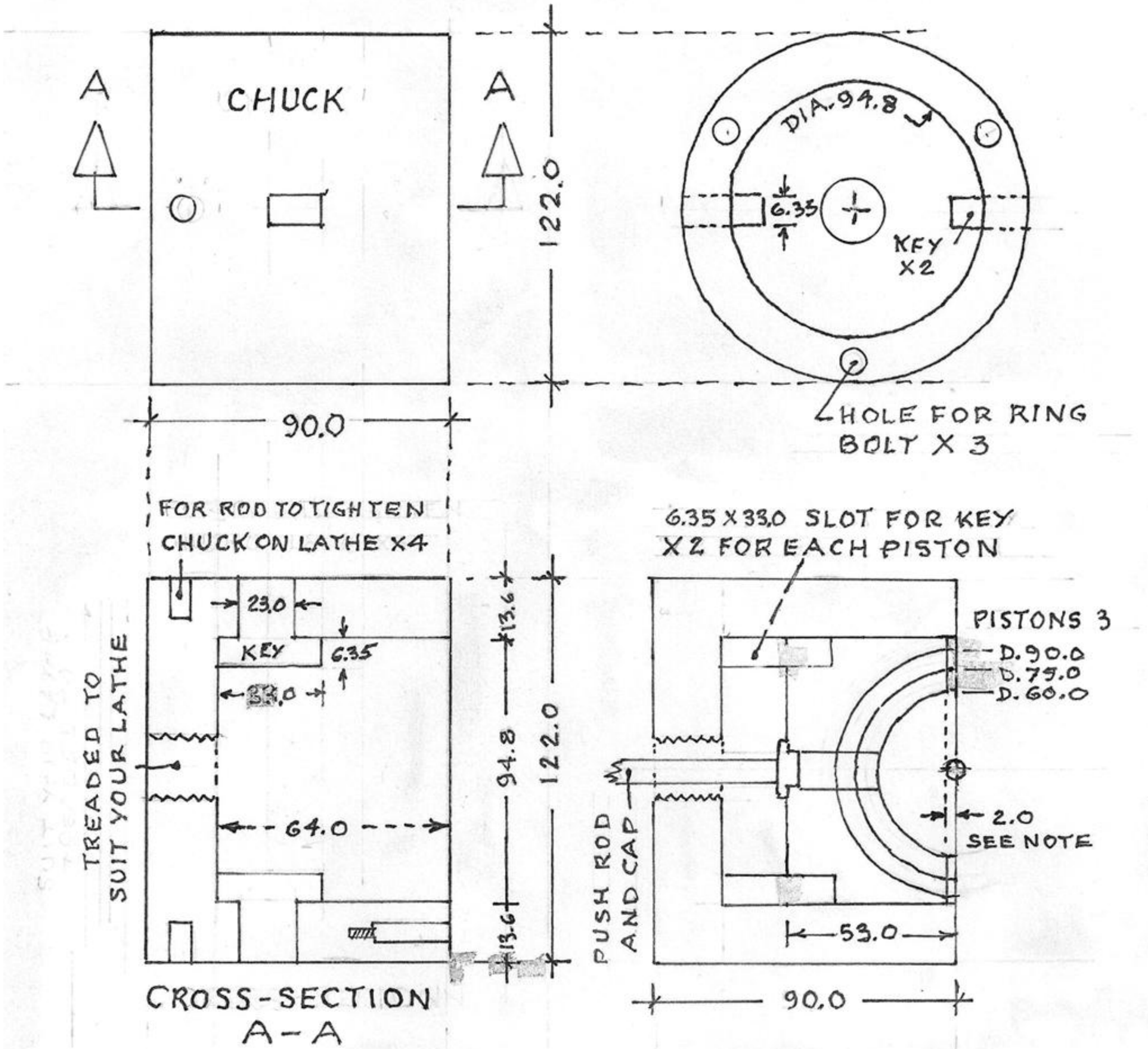
Each chuck is for a specific diameter of sphere. It is imperative that these chucks be made of multiple layers of the finest grade of plywood. Glue each layer with the wood grain cross wise. Should they be made from a solid block of wood they would very quickly become oval, no doubt whatsoever.

Below is a typical cross-section (schematic)



Mark one bolt hole on the chuck and its mate on the ring so as to reset the ring in the same order.

Piston Chuck (schematic)



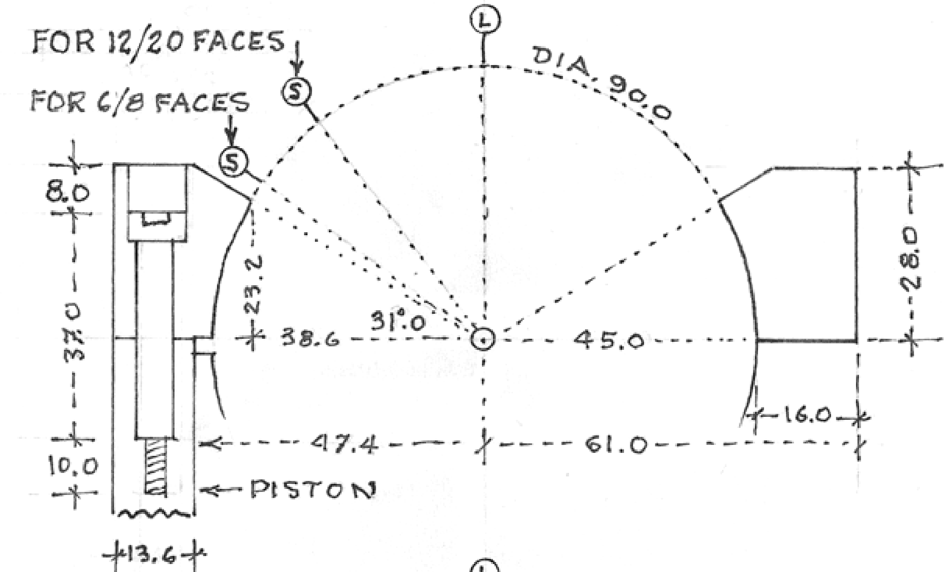
This chuck is useful if you are to do many of the same pieces, since you do not have to loosen the ring till the whole turning is finished. When you push the sphere there is no friction or rotation of the sphere.

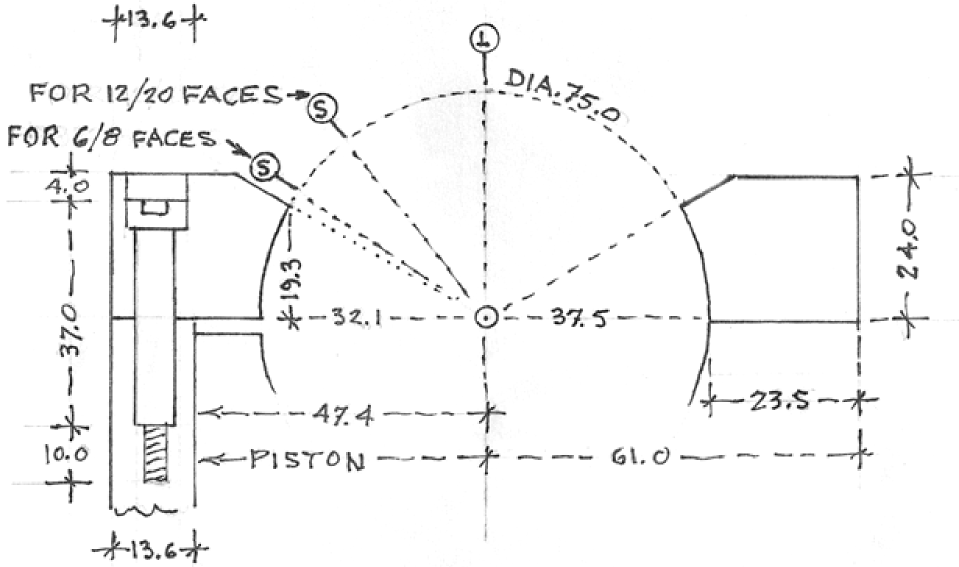
My chuck is made in Aluminum and the piston in Bakelite, that's what I had on hand!

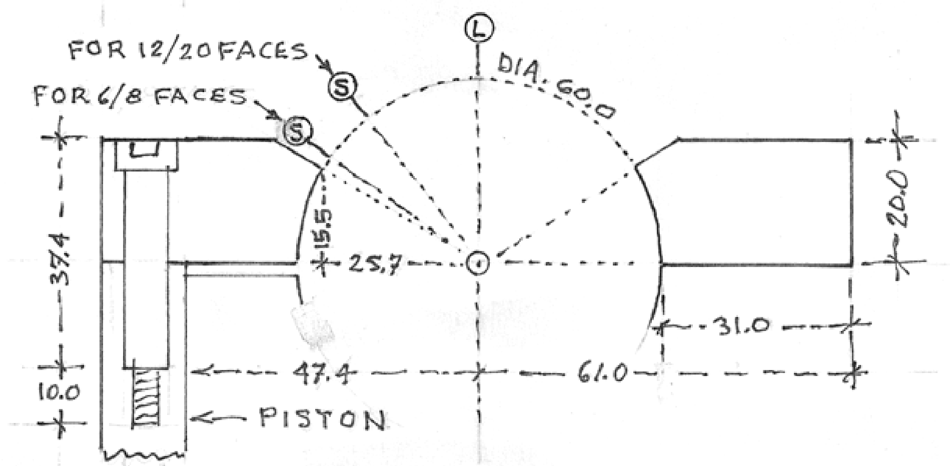
Note :
Cut off the 2.0 mm from the 53.0 mm only after having hollowed out the piston.

DO NOT USE FOR "TETRAHEDRON"

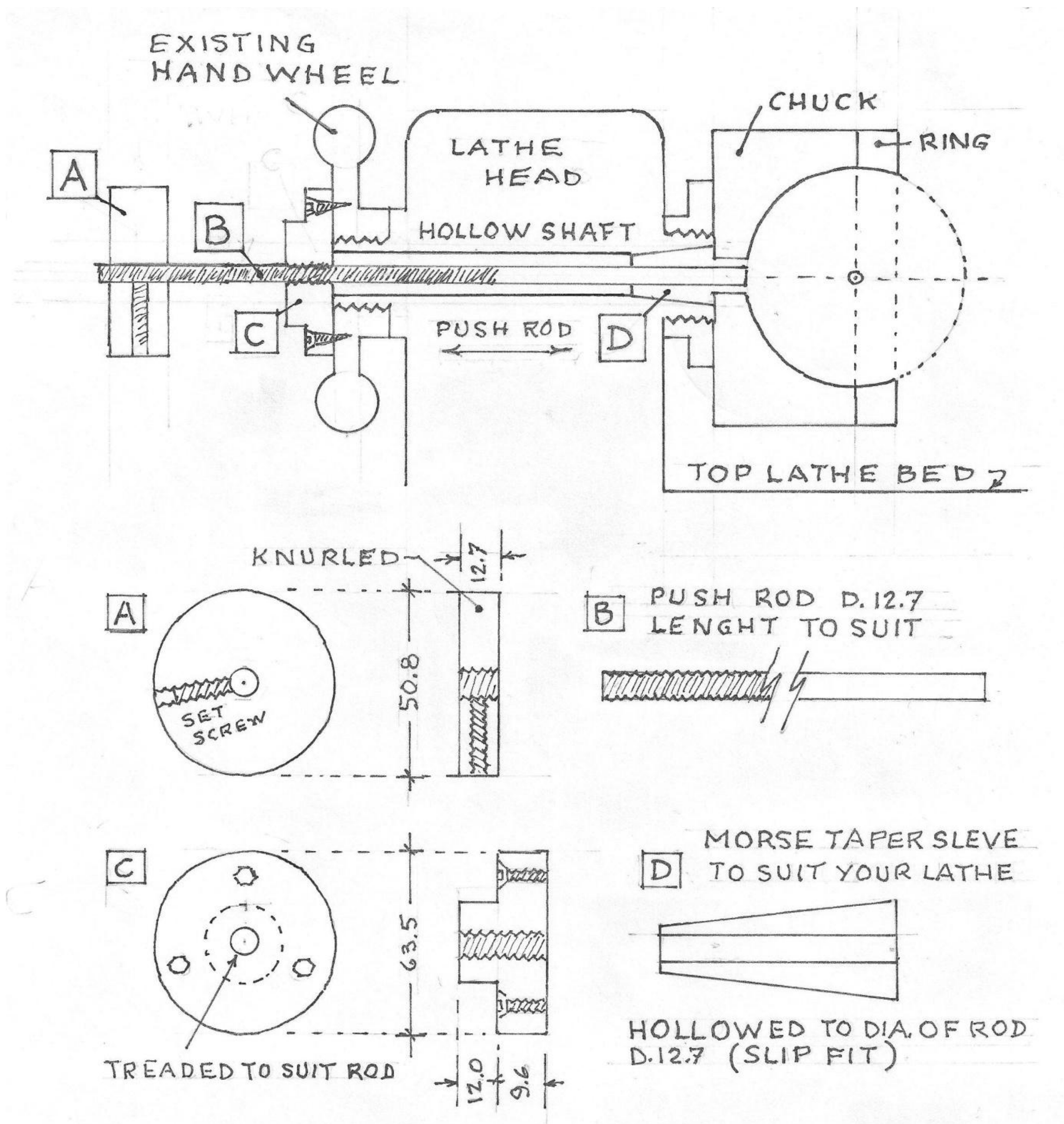
Piston Chuck Rings







Push Rod (schematic)

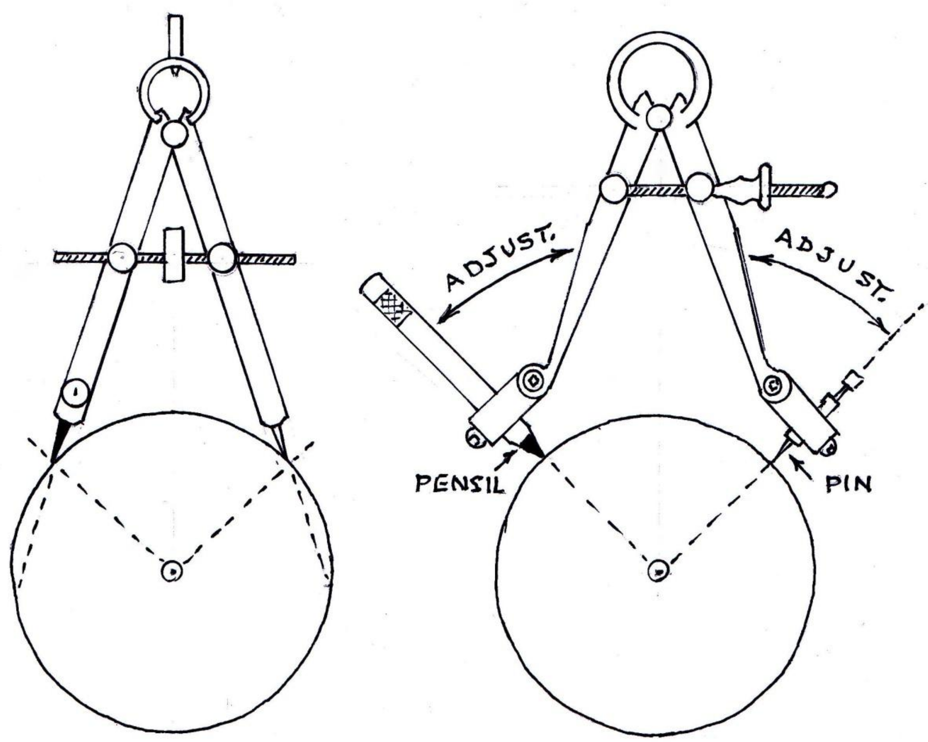


This push rod besides being used with the piston chuck was also used for the three following pieces :

- “Surprise”
- “Baker’s dozen”
- “Mysterium Cosmographicum"

Small Tools & Material

- ✓ Protractor
- ✓ Caliper
- ✓ Bench grinder (one grinding wheel on one side and a metal cutting one the other side)
- ✓ Hacksaw
- ✓ Files
- ✓ "MAP" gas
- ✓ Silver solder
- ✓ Regular compass
- ✓ Adjustable compass



REGULAR COMPASS
DIFFICULT TO MAKE
ACCURATES MARKINGS

MODIFIED DIVIDER.
PIN AND PENSIL POINT
TOWARDS CENTER

To Make a Turning (General)

Turn a Sphere (schematic)

1. First rough out a blank on the band-saw (fig. 1) and chuck tight,
2. Set jig pivot in line with the center of the projected sphere,
3. Lock the jig (fig. 2) and take small cuts up to a bit past the pivot line,
4. Measure often till the desired diameter is obtained,
5. Beware not to overcut
6. Do the same from the center of the sphere towards the chuck till complete separation of the sphere,
7. You might even leave a little nib of 2 or 3 mm and cut it off (fig. 3).

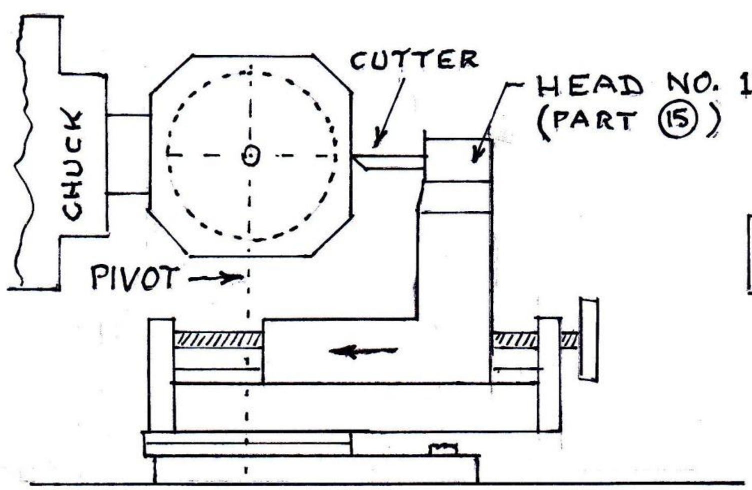


FIG. 2

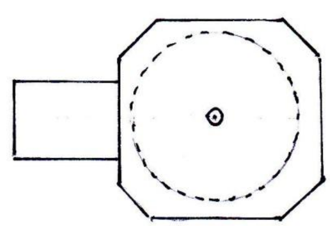


FIG. 1

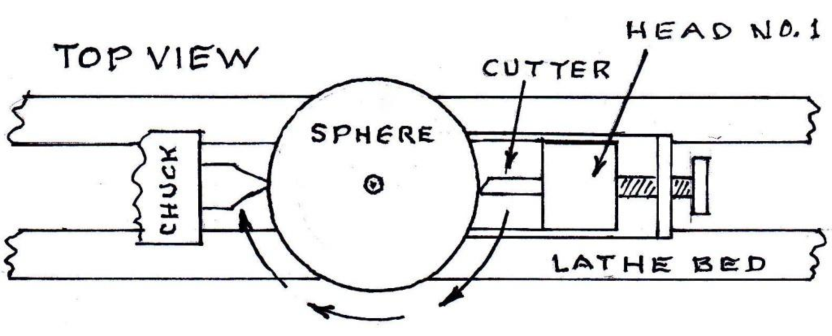


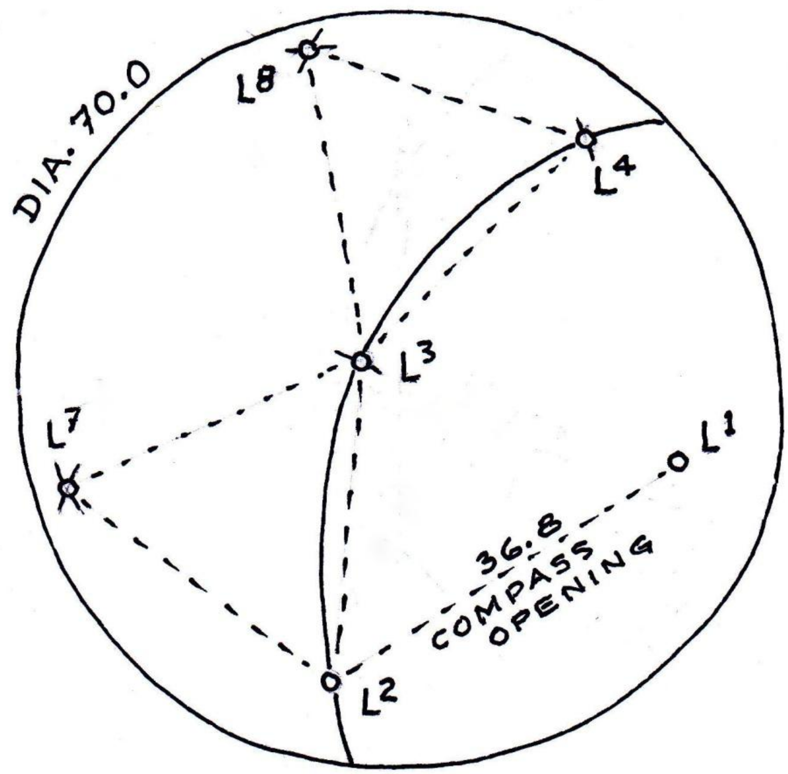
FIG. 3

Dividing the Surface of a Sphere

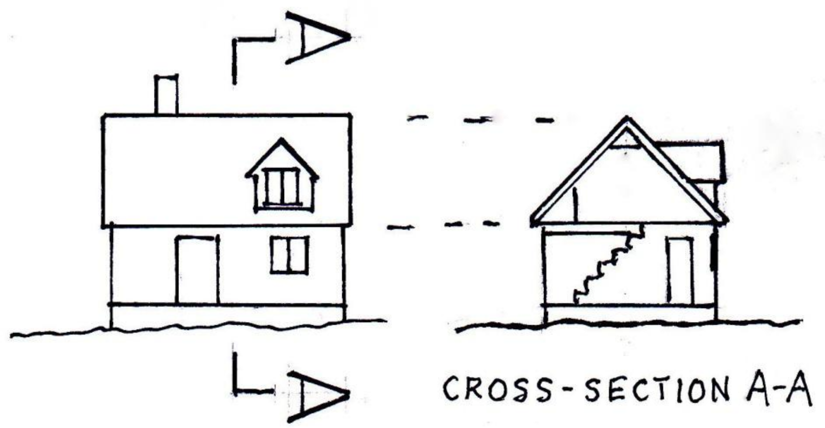
For example if we want to divide a sphere of a diameter of 70.0 mm in 12 equal parts, using the calculation chart we go to the 12 openings line and vertically to the L-L column where we find the factor 0.5257 which we multiply to the diameter : 70.0 x 0.5257 = 36.8. This is our L-L distance in a *straight* line. So open your compass at 36.8 and keep it open that way till you are all done (see figure next page).

1. With a pencil mark L^1 anywhere on the sphere.
2. With the compass pivoting on L^1 draw a full circle on which you mark L^2 anywhere you want on the circle.
3. With the compass pivoting on L^2 mark L^3 on the circle, compass on L^3 mark L^4, compass on L^4 mark L^5 and compass on L^5 mark L^6. Then check that compass on L^6 you get L^2, if it is not the case, erase everything and start all over again, your compass moved or your sphere is not perfect.
4. Always with your compass open, mark a short line from L^2 then from L^3, this intersection is L^7. Do the same with L^3 and L^4 to mark L^8 and so on to L^{11}. Again as is step 3, check from L^{11} to L^7.
5. With your compass (always open at 36.8) pivoting on L^7 mark a short line at L^{12} (opposite L^1), then from L^8 and so on from L^9, L^{10} and L^{11}. This should give you a multi-cross ✳. If all these fine short lines do not give a clear point, refine your work and check your compass until all is exact, otherwise later on when all the 12 openings are cut out, the amount of wood between openings will not be the same and it will show and this is not acceptable!

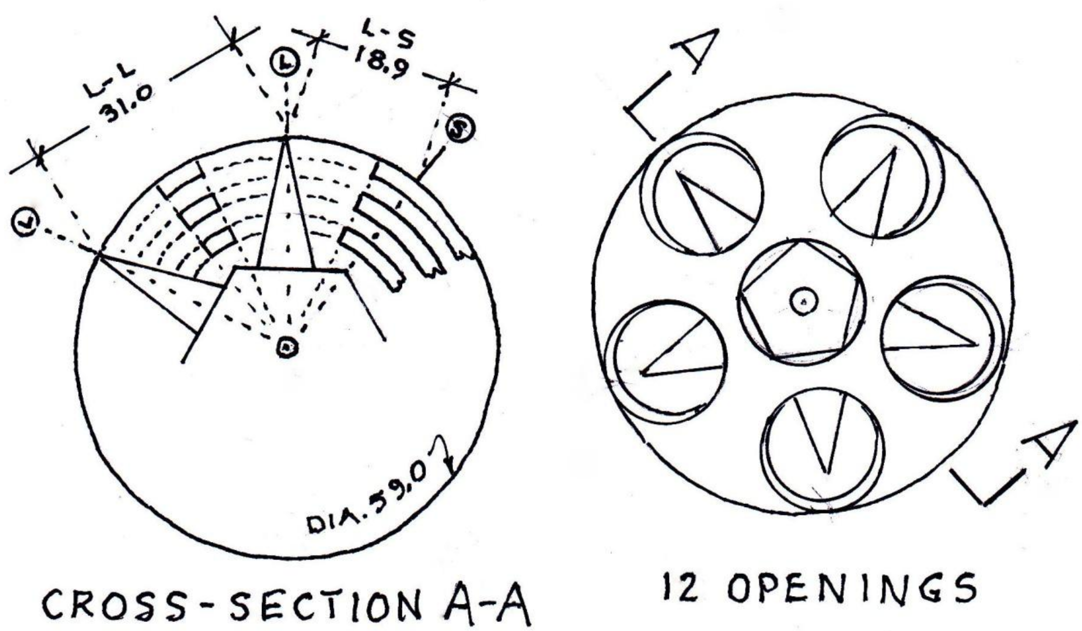
Dividing the surface of a sphere (schematic)



Cross-Section

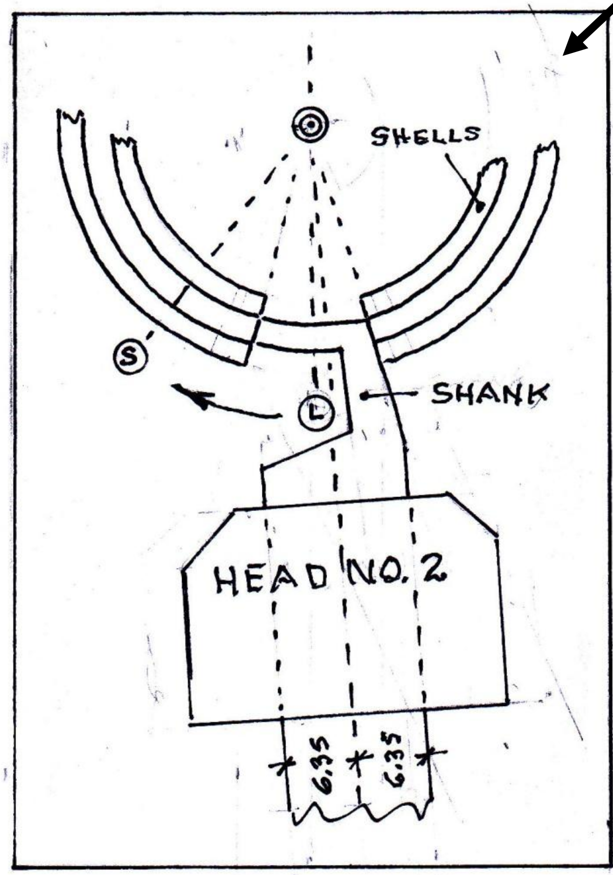


Take this house for example, if you were to cut it in two and scrap the left half and look towards the arrows, you would see what the drawing is showing : this is a cross-section.
It’s the same for a turning, the cross-section will show you what you want to make inside the sphere and permit you to design the tools you need to do the job.



Designing Tools

Sheet of transparent paper over your cross-section



Draw the max. size of tool that can go inside the opening and by pointing a pencil over the ⦿ point you can pivot the transparent sheet of paper and see (when the shank rubs against the edge of the opening) if the cutting edge reaches the Ⓢ line. If not, the opening is too small, if it over-reaches the Ⓢ line the opening could be made smaller, which is a good thing.

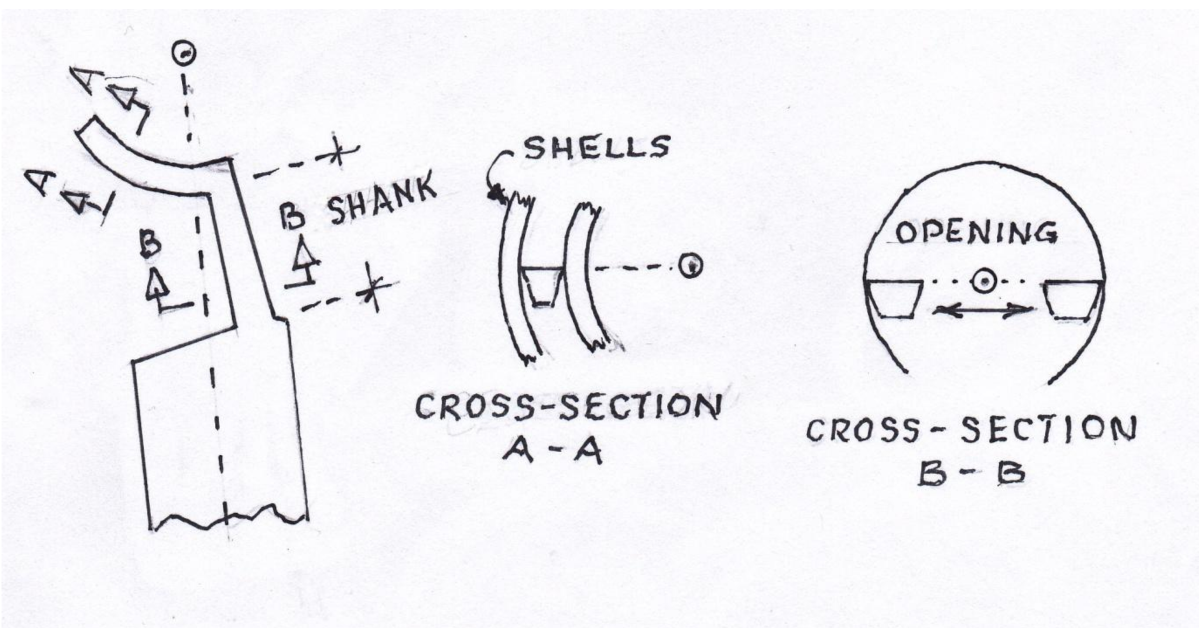
But if you do not want to reduce the opening, then you must cut off the part of the tool that is past the Ⓢ line.

Most of my tools are made from a 6.35 by 25.4 mm cold rolled flat steel bar. The width of the tool opening in head N°2 is 25.4 with a shim of 6.35 and the tool, also at 6.35 mm brings the top of the tool (cutting edge) just at center height of the lathe shaft.

For quite a longer tool, for more strength and to reduce vibration, you may want a thicker steel bar; say 9.6 or 12.7 so in that case the cutting edge would still have to be at center height and the extra thickness of metal would be above center height.

As for the part of the tool that goes inside the sphere, you must relieve the sides so that only the cutting edge is full width so that there is no friction between the shells.

Also, the left side of the shank acts as a stopper when it rubs against the edge of the opening.



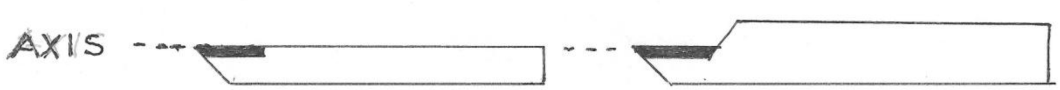
Making Tools

Coat the flat steel bar with “Metal Turner’s Blue” and from the drawings on the transparent paper (see designing tools) scribe the shape of the tool.

For cutting away the unwanted metal, use a hacksaw, bench grinder (cut off wheel and grinding wheel) and files; it is easier than it looks. The refining of the tool will be done on the simulator plate.

You can also easily and at little cost convert a wood cutting band saw by to simply changing the blade to a metal cutting one and the pulleys so as to reduce the speed of the blade ± 50/70 m/min (equal to 150/200 feet/min).

As for the cutting edge, I use a piece of an old jointer or planer blade that I cut oversize and silver solder it using a small torch and a can of “MAP” gas (propane or butane is not hot enough). Then I will refine the shape on the grinding wheel when it is time for the “simulator plate”.



About Claude Lethiecq

Born in Montréal in 1933, after a career working on civil engineering projects, mostly abroad, and the first seven years of his retirement spent with his wife on a sailboat, Claude sailed across the Atlantic back to North America. He settled near Montréal, built a house and realized a childhood dream : set up his own workshop. He first used it to make his furniture but then discovered Woodturning. He was soon attracted by the challenges of "Tour de Force" turning, once practiced by the European royalty until the end of the XVIIth century. He specialized in creating one of a kind pieces, some of which were considered as unfeasible!

All his pieces are made from a single piece of wood, a solid sphere and despite their complexity, everything is machined on a lathe : nothing is sculpted, nothing is added or glued (except the finals).

The design of such pieces required the development of specific jigs, tools and calculations.

Claude is a member of AAW (USA), AFTAB (France) and WIW (QC, Canada).

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E-mail : lethiecqcl@gmail.com

The Battle

Turning is one long battle
With one solid piece of wood
And you must never settle
For half-victories
One must probe and explore
Meticulously cutting and slicing
To realize your finest work

John Mallette

Tour de Force

A - Chinese Ball

Claude LETHIECQ

~ Sequence of operations ~

Item

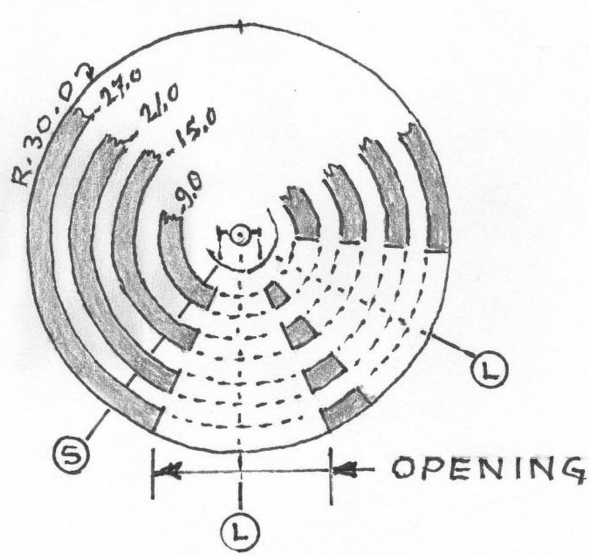
1. Draw cross-section
2. Make tool N°1 and chuck
3. Make tool N°2 and chuck ring
4. Turn sphere Ø 60.0, mark 12 Ⓛ points (Dodecahedron) use head N°1
5. Calculate minimum opening
6. Draw tools N° 3 to 6
7. Draw tools N° 7 and 8 and plugs
8. Draw tool N°4 in sphere jig
9. Draw tool N°5 in sphere jig
10. Draw tool N°6 in sphere jig
11. Draw tool N°7 in sphere jig
12. Draw tool N°8 in sphere jig
13. Make tools N° 3 to 8 and plugs
14. Trace cross-section on simulation plate
15. Refine the tools
16. Place sphere in chuck and loose ring, align one Ⓛ point and tighten chuck ring
17. Proceed with the tools N° 3 to 8 (items N° 6 to 12) and set plug
18. Release pressure on ring, align another Ⓛ point, tighten chuck ring and repeat item N° 16 and 17 till all 12 Ⓛ points are done.
19. Use piston chuck if you have one to replace items N°2 and 3.

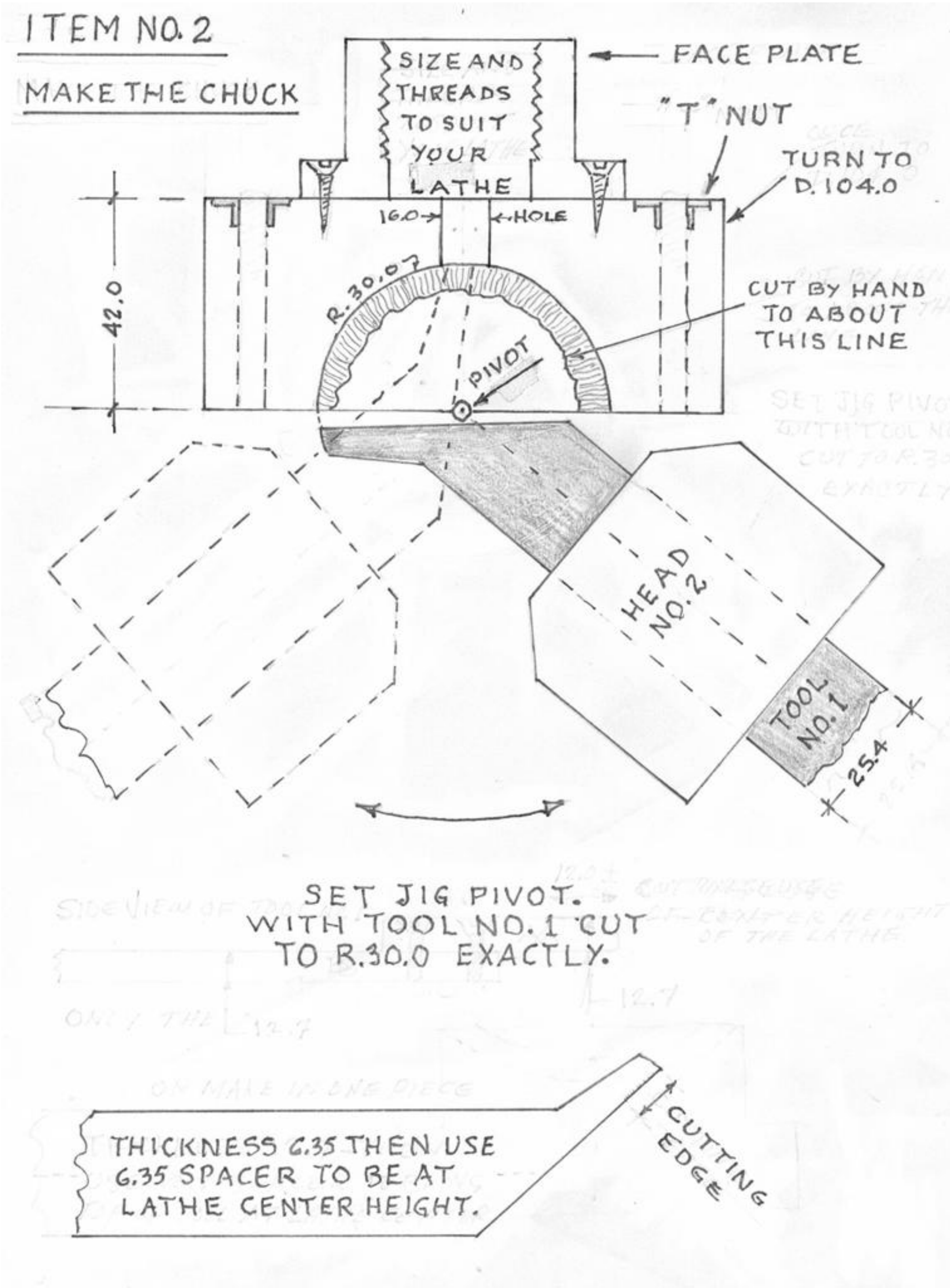
Item N°1

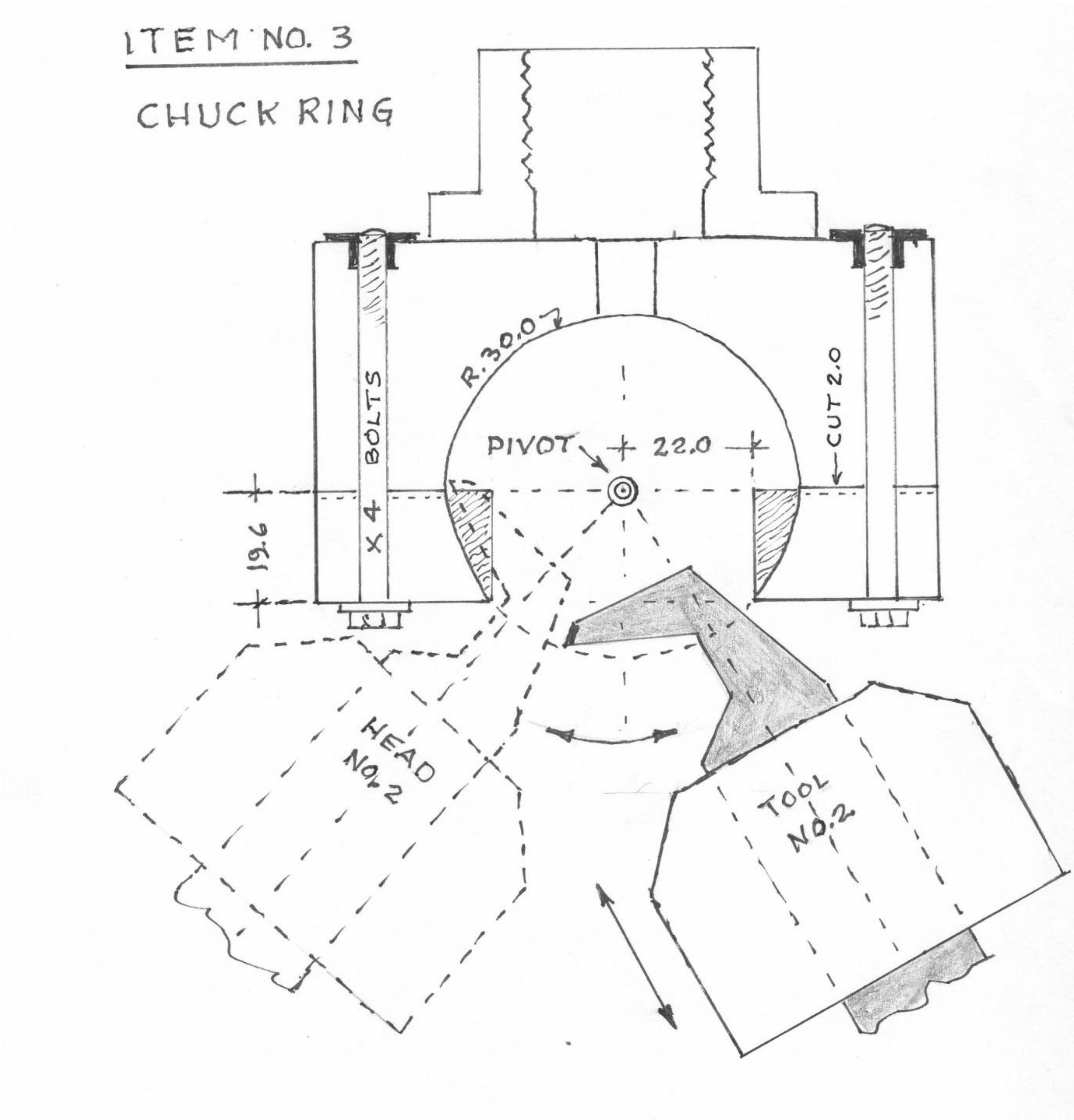
~Chinese Ball ~

cross-section

As a first turning, draw a sphere Ø 60.0 consisting of 4 concentric spheres of 3.0 thickness and 3.0 cuts between spheres. Use Dodecahedron divisions for 12 openings (see calculating chart : L-L = 60.0 x 0.5257 = 31.5 and L-S = 60.0 x 0.3204 = 19.2).
Calculate the smallest opening (see next page and the note on item N°5 tool N°5)




ITEM NO. 2
MAKE THE CHUCK
SIZE AND THREADS TO SUIT YOUR LATHE
FACE PLATE
"T" NUT
TURN TO D.104.0
16.0
HOLE
42.0
R.30.07
CUT BY HAND TO ABOUT THIS LINE
PIVOT
HEAD NO. 2
TOOL NO. 1
25.4
SET JIG PIVOT. WITH TOOL NO. 1 CUT TO R.30.0 EXACTLY.
THICKNESS 6.35 THEN USE 6.35 SPACER TO BE AT LATHE CENTER HEIGHT.
CUTTING EDGE



A- Set jig pivot

B- Set and turn the ring

C- Cut opening in ring R 22.0

D- Make tool N°2

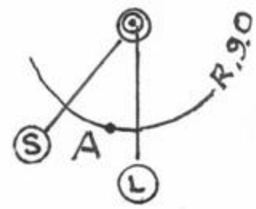
E- Take only small cut advance tower for another small cut till you reach the opening in the chuck (exactly)

F- Cut off 2.0 from inside face of the ring

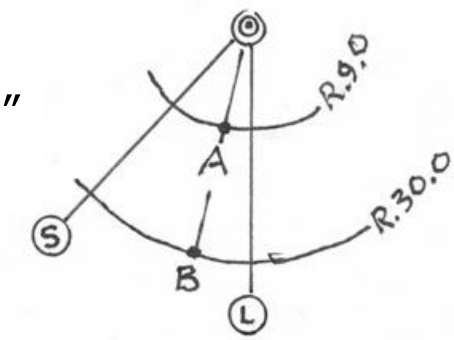
ITEM N° 5 (not to scale)

To determine the smallest opening :

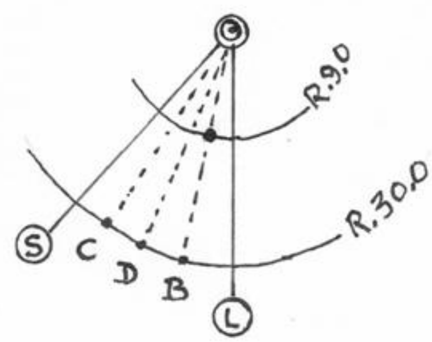
Smallest width of the tool shank at R 9.0, mark that distance “A” to the left of line Ⓛ.



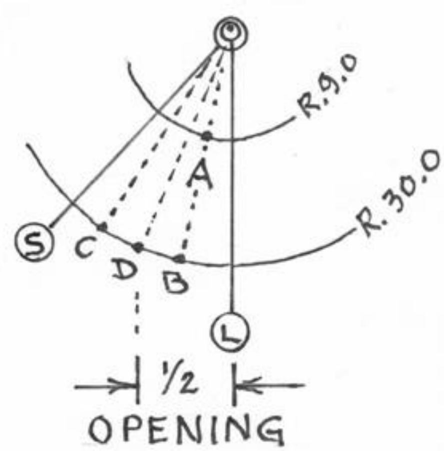
Draw a line from ⦿ through ”A” and down to R 30.0, mark “B”



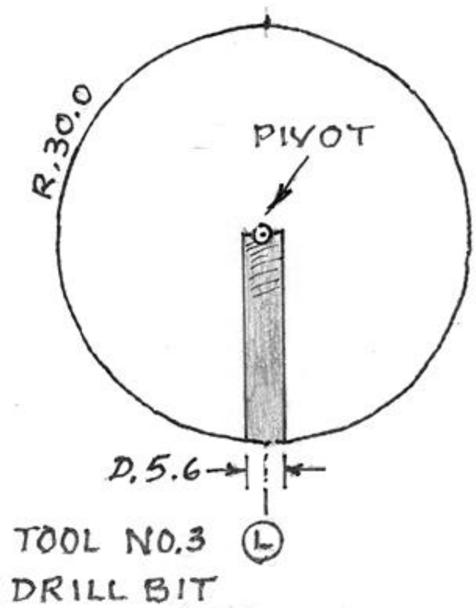
With a protractor, divide distance Ⓢ to “B” along the curve in 3 equal parts, mark “C” and “D”

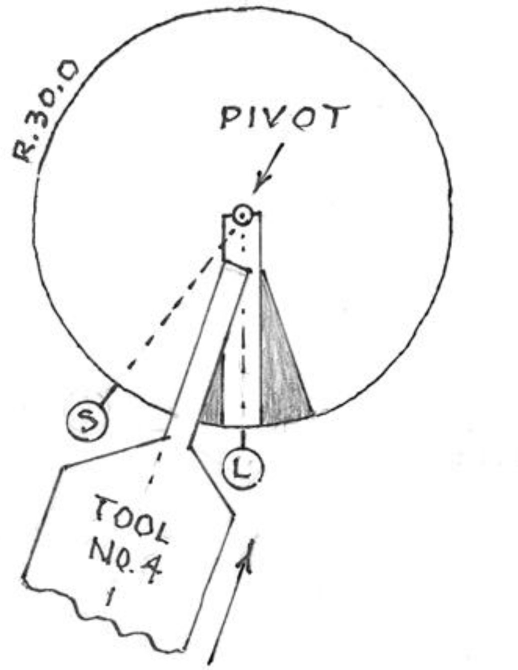


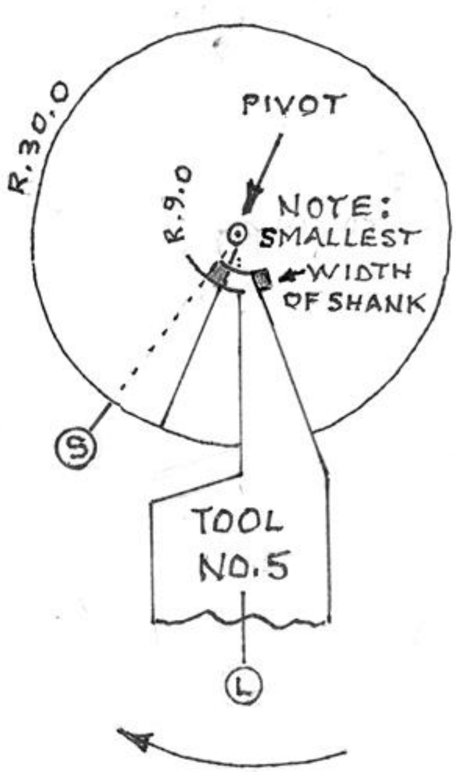
Therefore, the distance from “D” to Ⓛ line = ½ opening

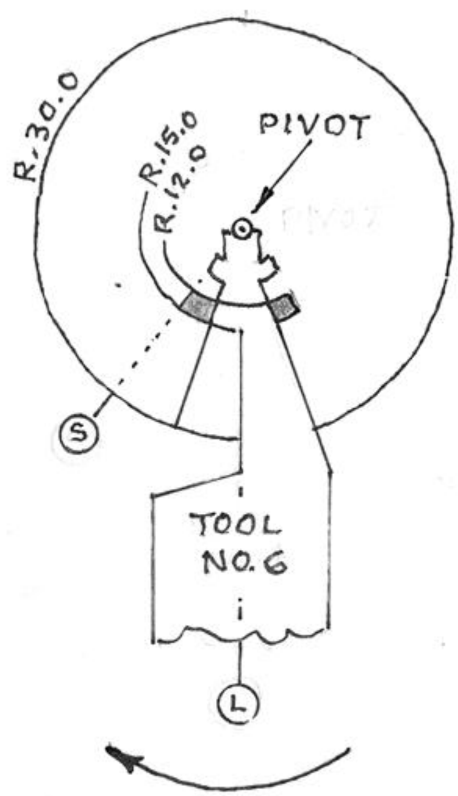


ITEM N°6

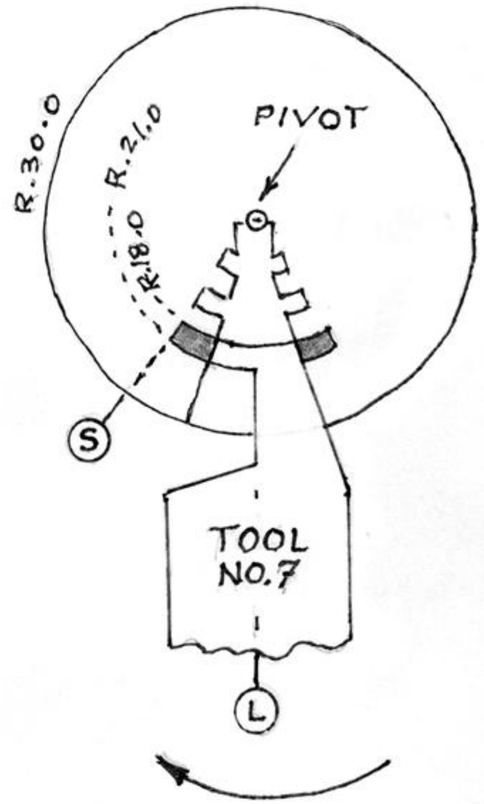

R.30.0
PIVOT
D.5.6
L
TOOL NO.3
DRILL BIT

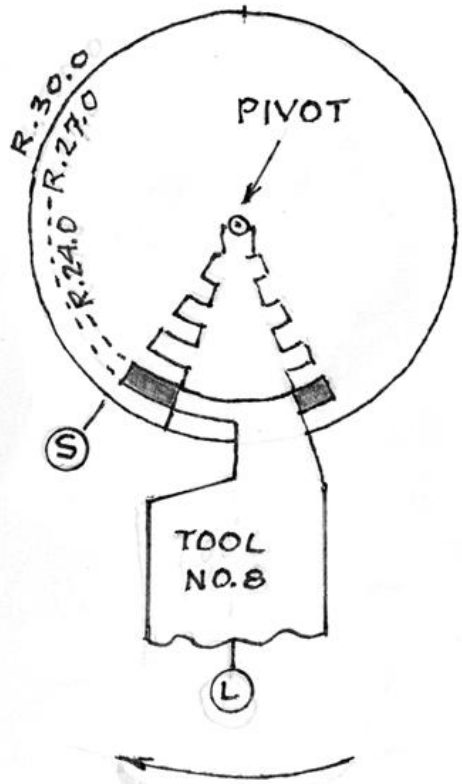

R.30.0
PIVOT
S
L
TOOL
NO.4

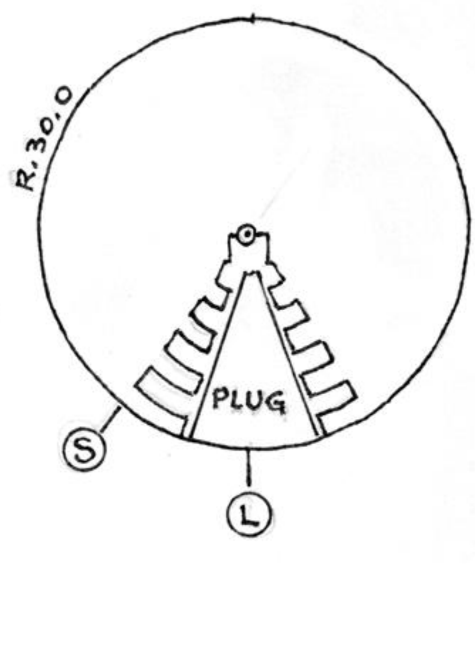

R.30.0
PIVOT
R.9.0
NOTE:
SMALLEST
WIDTH
OF SHANK
S
TOOL
NO.5
L


R.30.0
R.15.0
R.12.0
PIVOT
S
TOOL
NO.6
L

ITEM N°7

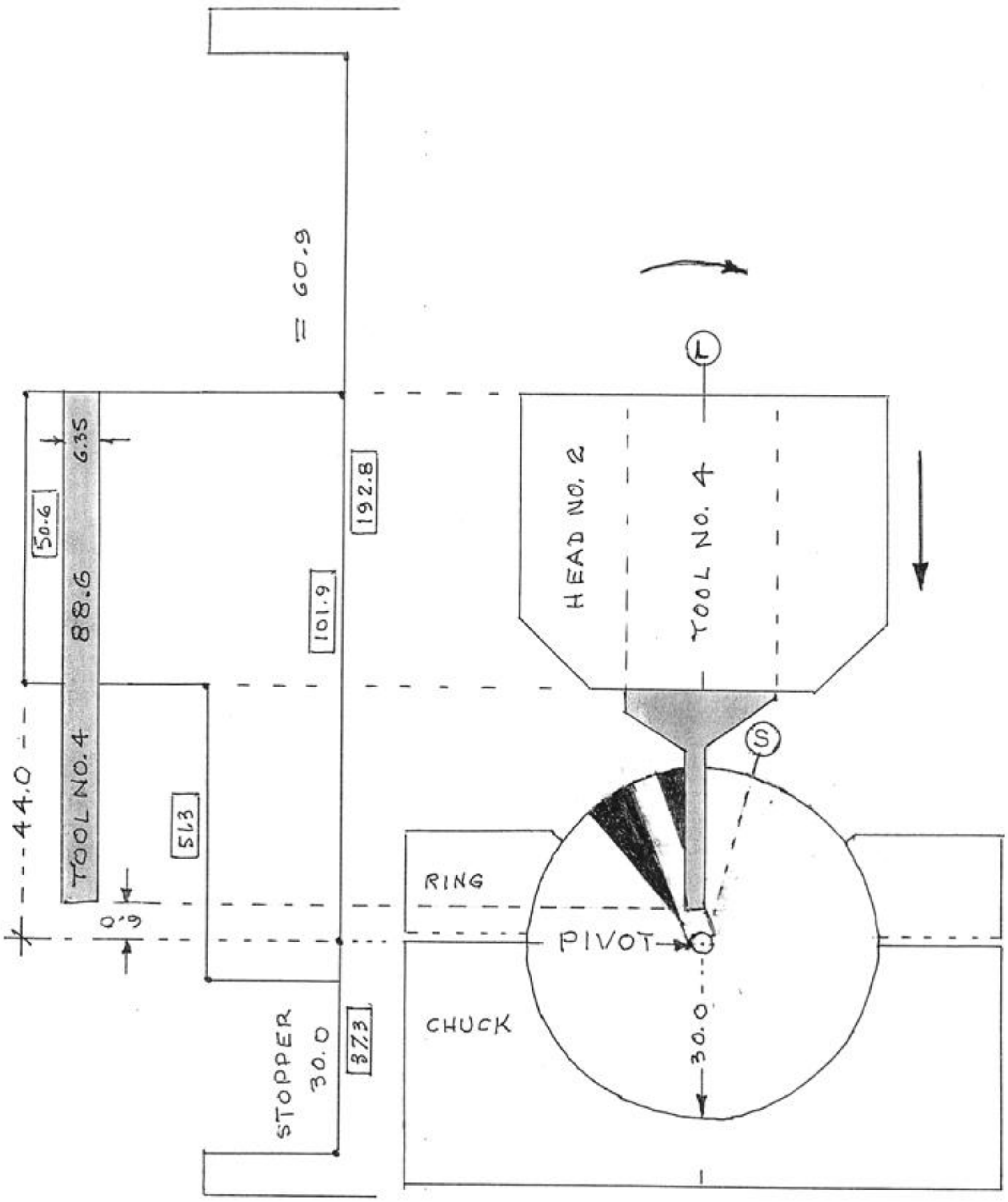




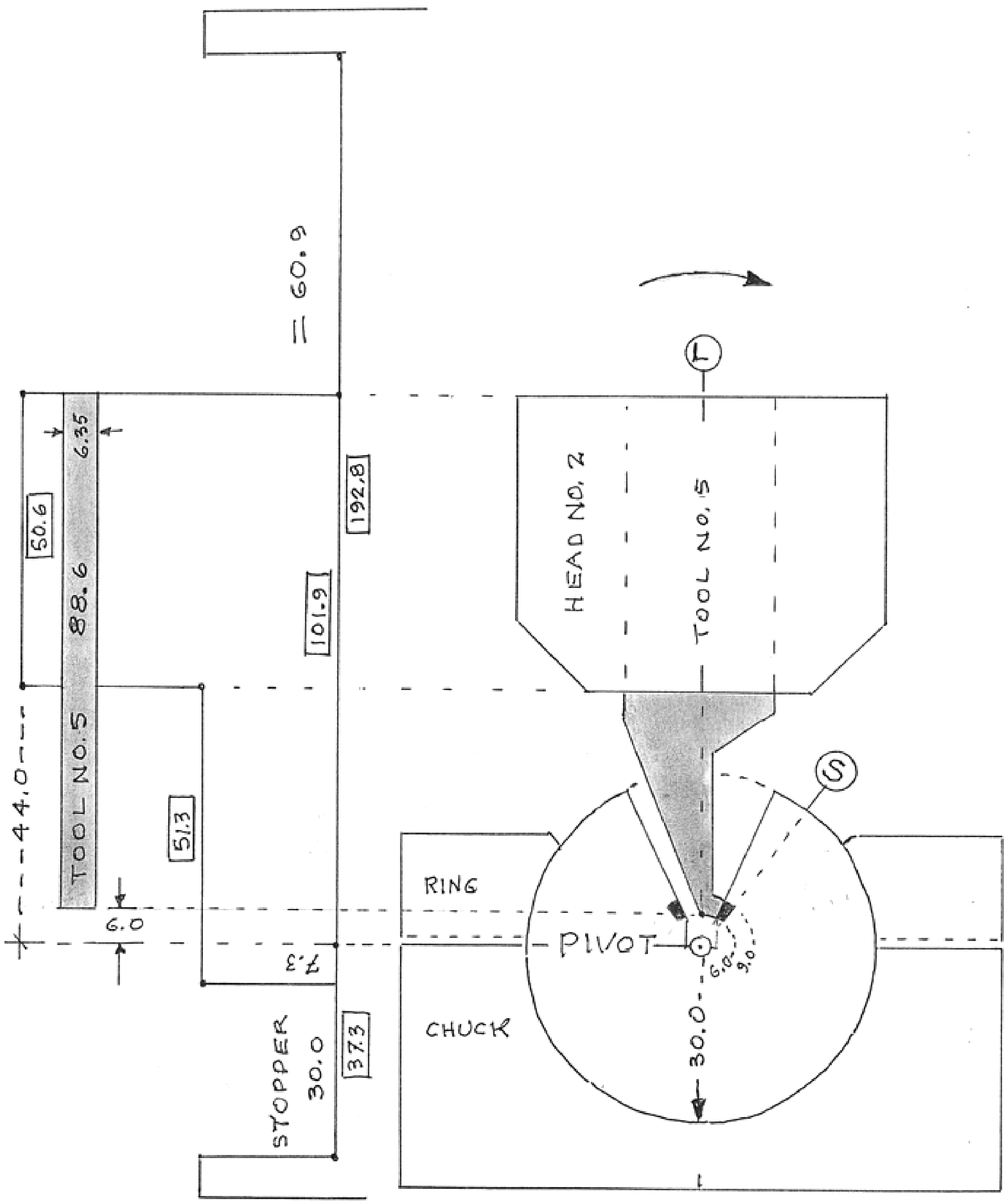


OR MAKE COMBLIKE
TOOL TO CUT ALL 4
SHELLS IN ONE PASS.

ITEM NO.8

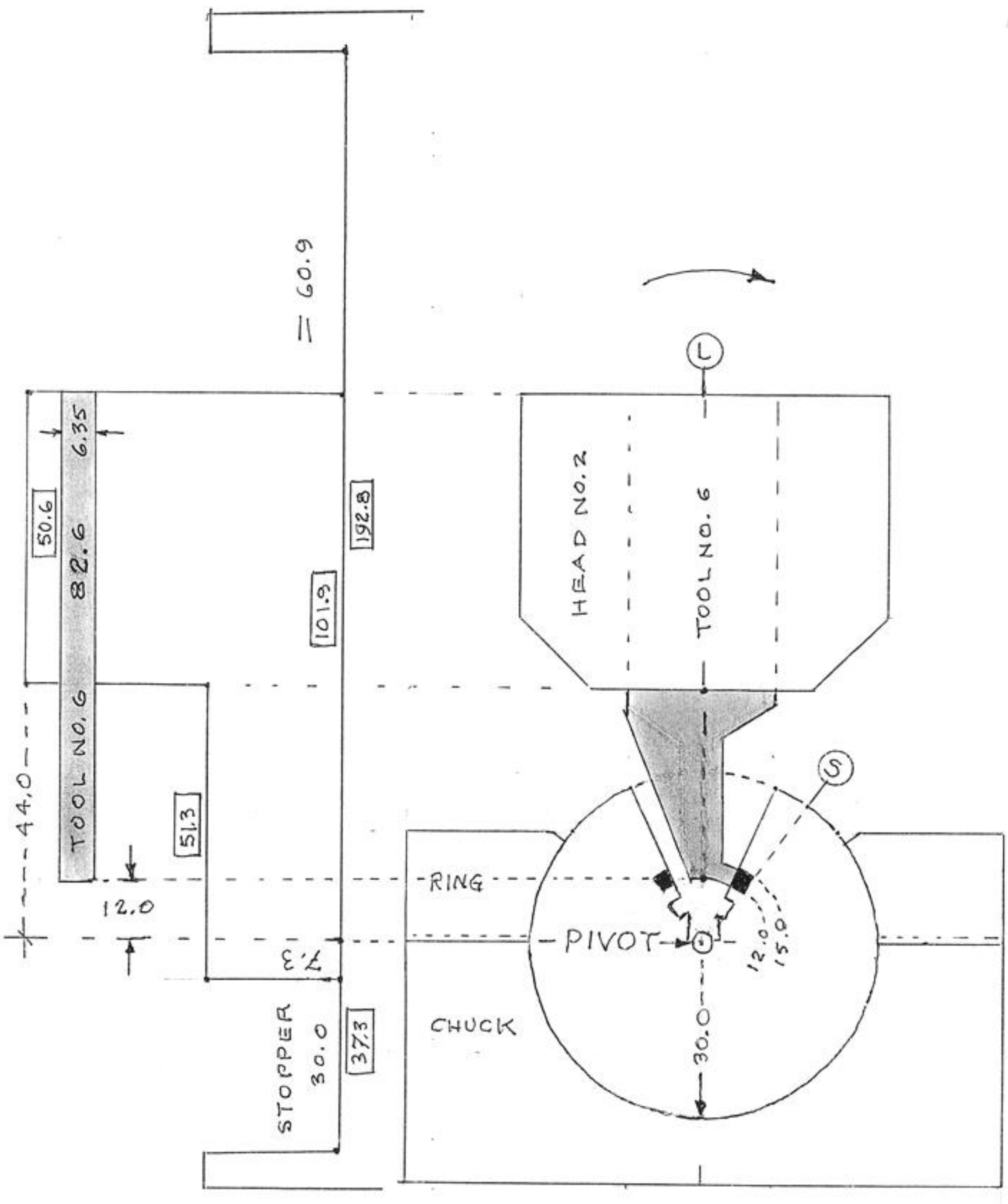

= 60.9
L
HEAD NO. 2
TOOL NO. 4
192.8
50.6
88.6
6.35
101.9
TOOL NO.4
44.0
51.3
S
RING
PIVOT
CHUCK
STOPPER
30.0
37.3
30.0

ITEM NO. 9



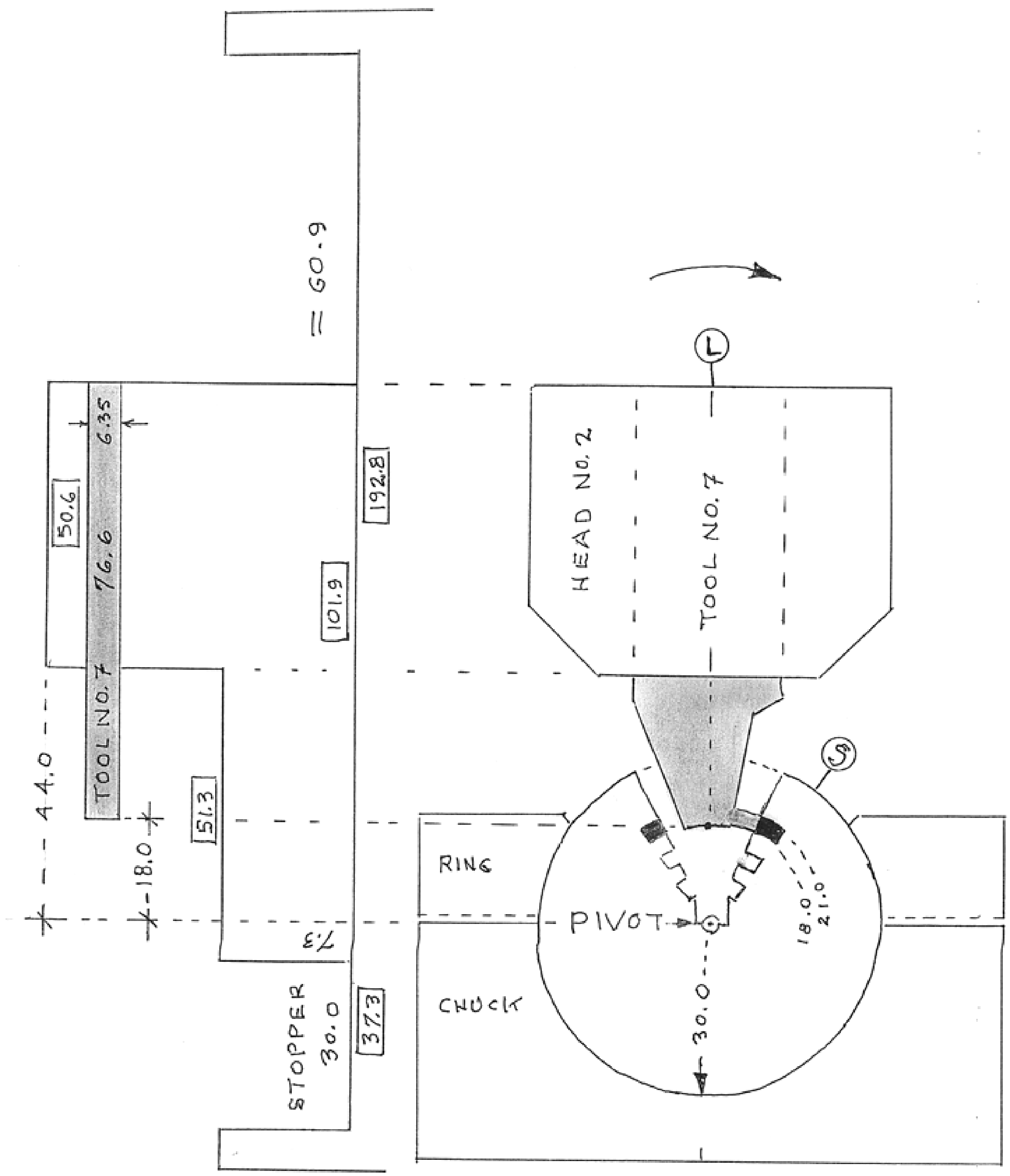
= 60.9
192.8
50.6
6.35
88.6
101.9
HEAD NO. 2
TOOL NO. 5
44.0
TOOL NO. 5
51.3
RING
6.0
PIVOT
7.3
6.0
9.0
CHUCK
STOPPER
30.0
37.3
30.0

ITEM NO.10

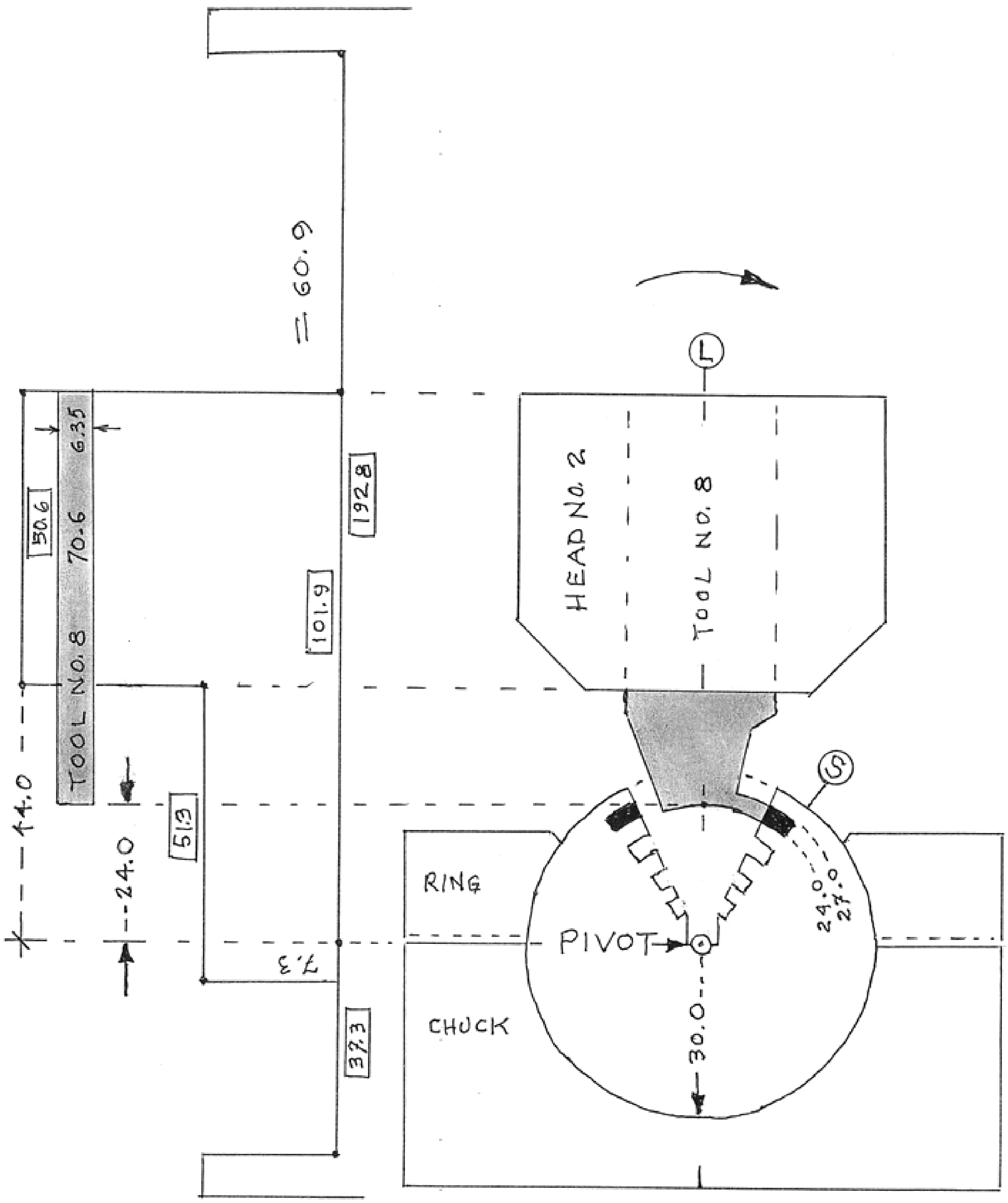


= 60.9
L
6.35
50.6
82.6
192.8
101.9
HEAD NO.2
TOOL NO. 6
TOOL NO. 6
44.0
51.3
S
RING
12.0
PIVOT
7.3
12.0
15.0
CHUCK
STOPPER
30.0
37.3
30.0

ITEM NO. 11


= 60.9
L
HEAD No. 2
TOOL No. 7
6.35
50.6
76.6
192.8
101.9
TOOL No. 7
44.0
18.0
51.3
7.3
RING
PIVOT
18.0
21.0
CHUCK
30.0
STOPPER
30.0
37.3

ITEM NO.12


60.9
L
HEAD No. 2
TOOL No. 8
6.35
70.6
30.6
TOOL No. 8
192.8
101.9
44.0
24.0
51.3
S
RING
PIVOT
24.0
27.0
7.3
CHUCK
37.3
30.0

Tour de Force

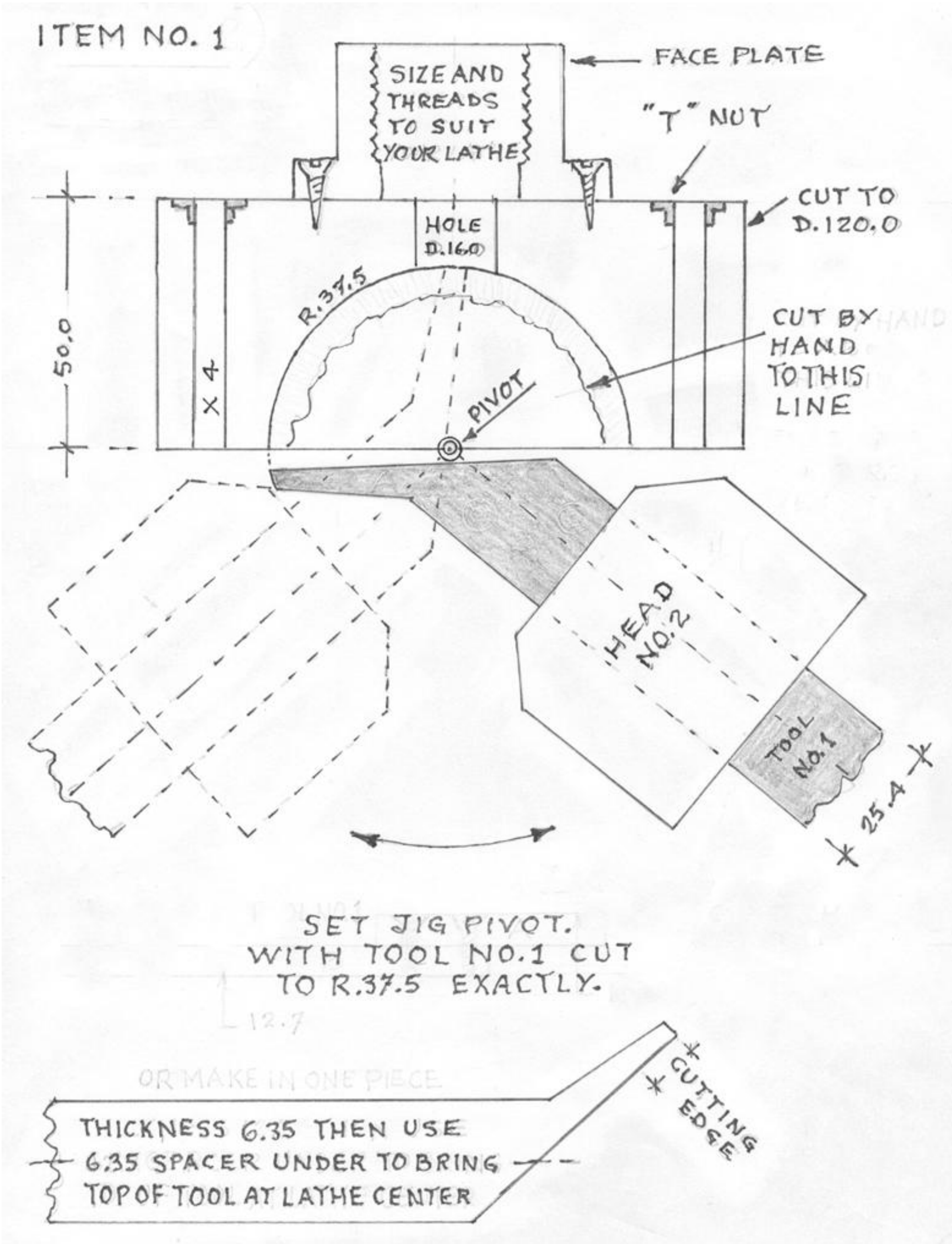
B - Spiked Dodecahedron in 3 concentric spheres

Claude Lethiecq

~ Sequence of operations ~

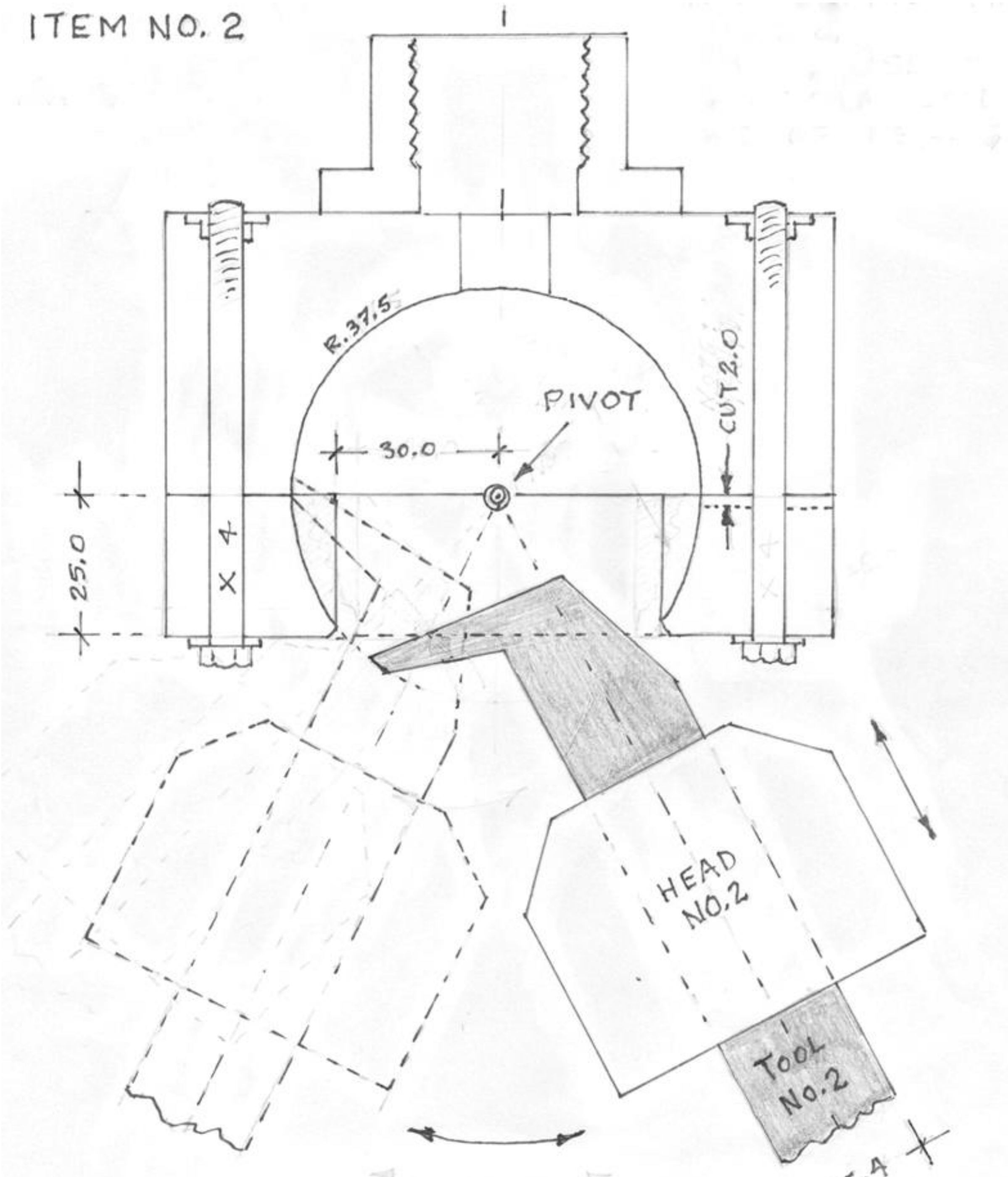
Item

1. Make tool N°1 and chuck
2. Make tool N°2 and chuck ring
3. Draw cross-section (text)
4. Draw cross-section (drawing)
5. Turn sphere Ø 75.0, use head N°1, mark 12 Ⓛ points and 20 Ⓢ points (Dodecahedron divisions)
6. Draw tools N° 3 to 6
7. Draw tools N°7 and 8 and plugs
8. Draw tool N°3 in sphere jig
9. Draw tool N°4 in sphere jig
10. Draw tool N°5 in sphere jig
11. Draw tool N°6 in sphere jig
12. Draw tool N°7 in sphere jig
13. Draw tool N°8 in sphere jig
14. Make tools N° 3 to 8 included
15. Draw cross-section on simulation plate and refine all tools
16. Set sphere in the chuck, align an Ⓛ point, set ring, set jig pivot at ◎, set stopper against left side of jig base, back off jig and set a spacer of 32.5 against stopper and reset jig and lock
17. Angle jig 13° and proceed with tool N°3
18. Remove 32.5 spacer and reset jig against stopper to be back on ◎
19. Angle jig so tool N°4 cuts the opening
20. Unlock rotation of jig and proceed with tools N°5,6 and 7 or 8, then add plugs
21. Loosen ring and align another Ⓛ point and repeat item N° 16 to 20 included till all 12 Ⓛ points are done



ITEM NO. 1
SIZE AND THREADS TO SUIT YOUR LATHE
FACE PLATE
"T" NUT
CUT TO D.120.0
HOLE D.16.0
R.37.5
50.0
X 4
CUT BY HAND TO THIS LINE
PIVOT
HEAD NO.2
TOOL NO.1
25.4
SET JIG PIVOT.
WITH TOOL NO.1 CUT
TO R.37.5 EXACTLY.
CUTTING EDGE
THICKNESS 6.35 THEN USE
6.35 SPACER UNDER TO BRING
TOP OF TOOL AT LATHE CENTER

ITEM NO. 2



DETAILS OF TOOL NO.1
APPLICABLE TO TOOL NO.2
EXCEPT CUTTING END.

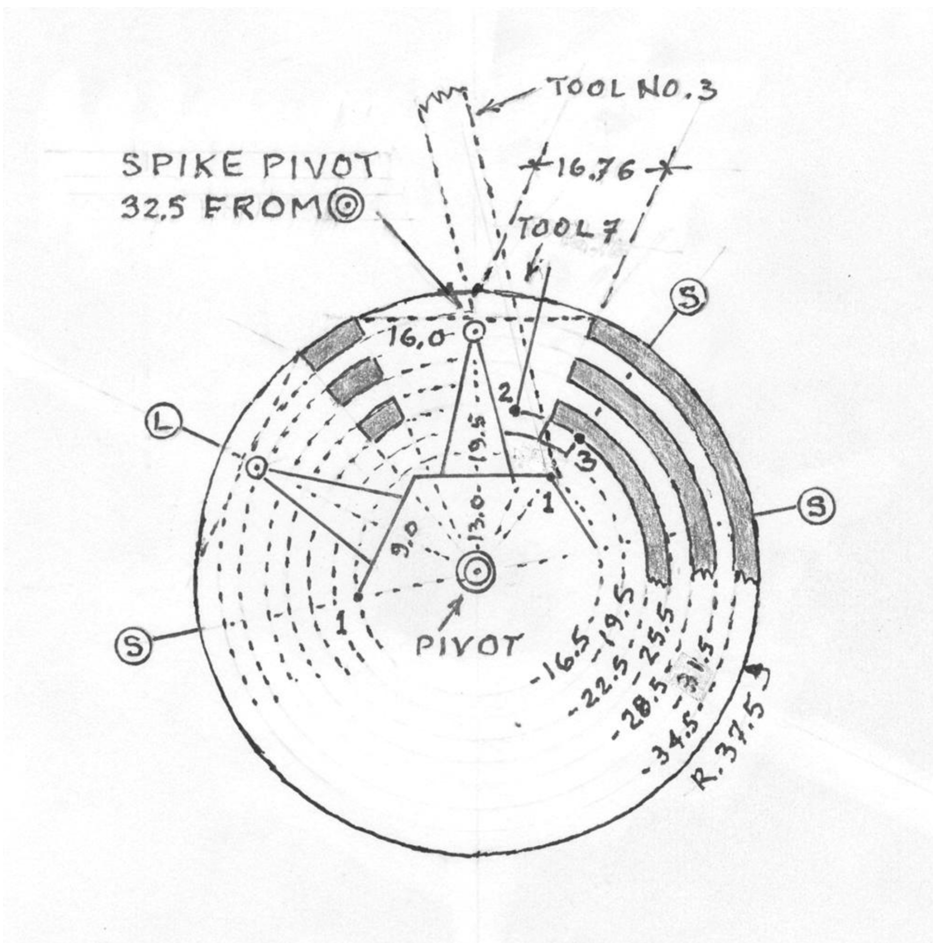
ITEM N°3 - Cross-section -

A. Draw sphere Ø 75.0
B. Draw 7 circles starting at R.16.5 and adding +3.0 to the others (3 shells of 3.0 with 3.0 cut between)
C. Mark 2 Ⓛ points and 3 Ⓢ points, use calculation chart
D. Mark dot 1 at intersection of R 16.5 circle and each of the 2 Ⓢ lines
E. From dot 1 draw a line perpendicular to Ⓛ and ⦿ line for 2 faces of the dodecahedron
F. Draw the 2 spikes
G. To the right of one spike draw part of tool N°7 to show the smallest width of the shank, mark dot 2
H. Mark dot 3 at the intersection of Ⓢ line and R22.5 circle
I. Edge of opening is halfway between dot 2 and 3, mark dot 4
J. Draw a line from ⦿ to dot 4 and on to R 37.5 circle to show half the opening
K. Transfer half opening to the other side and do the same to the right of the other spike. In between is what remains of wood
L. Draw tool N°3, the long point should reach dot 1
M. The point of the spike is the pivot of the sphere jig to cut the spike
N. Measure the angle of one side of the spike and the vertical Ⓛ-⦿ line. On this drawing the angle is 13°
O. There are no set rules to design such a piece (you need a good eraser). Start with a rough sketch of what you had in mind, keep trying until everything fits and looks balanced, make sure the tools can go in and do the job.

Use calculation chart for a 12 openings dodecahedron :

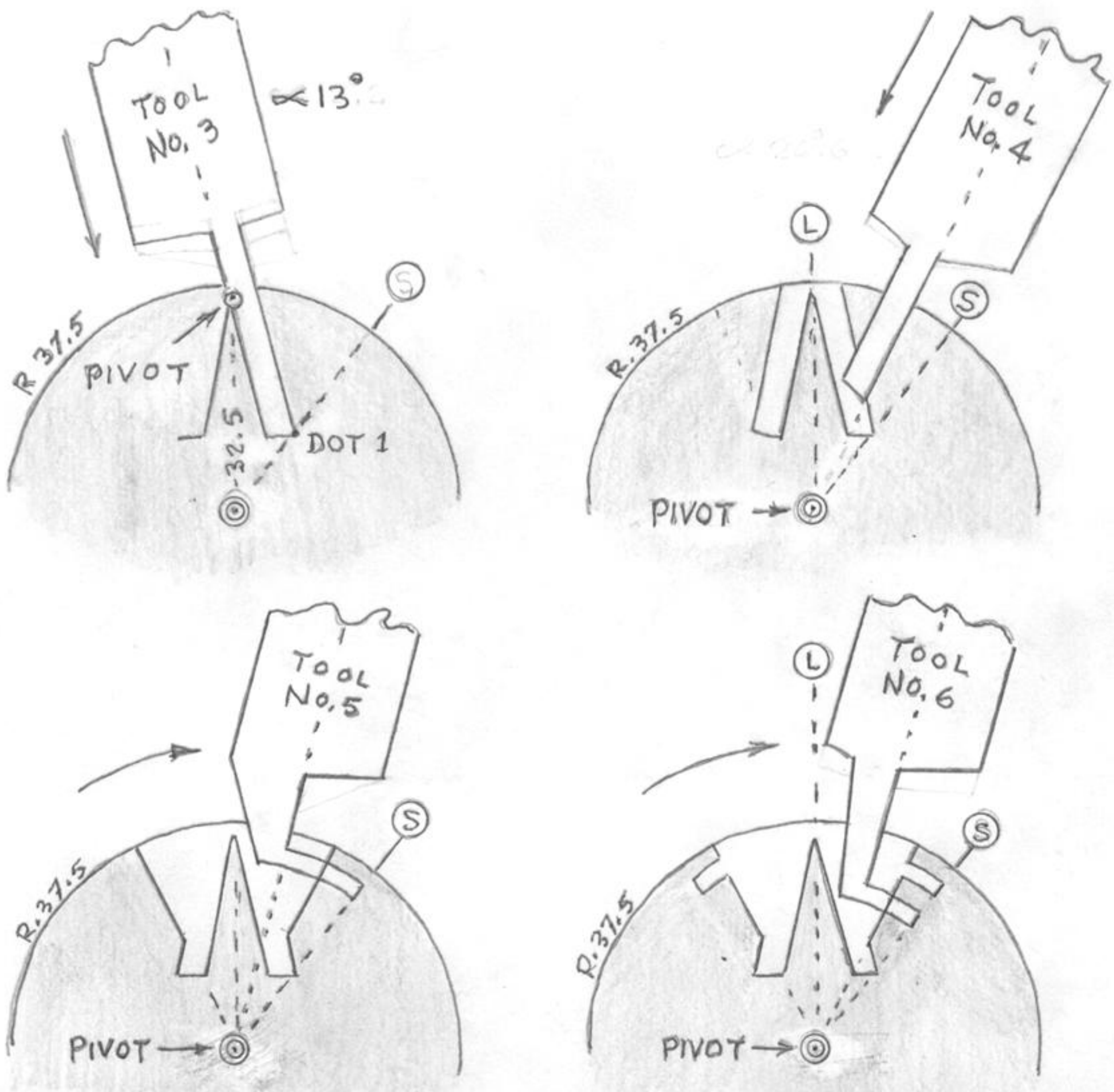
L-L = D 75.0 x 0.5257 = 39.43
L-S = D 75.0 x 0.3204 = 24.03

Angle = 13°

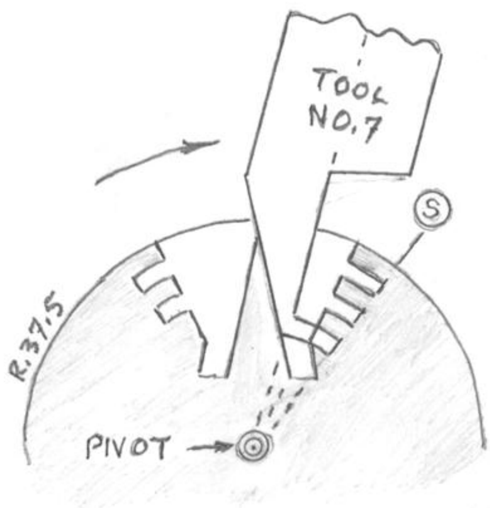


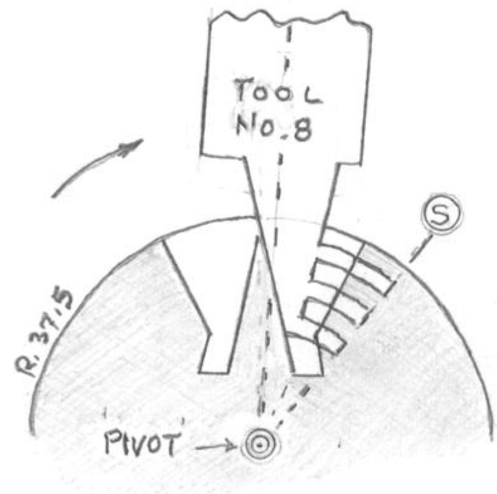
Item N°6

TOOLS NOS. 3, 4, 5 AND 6



Item N°7 TOOLS NOS. 7,8 AND PLUG

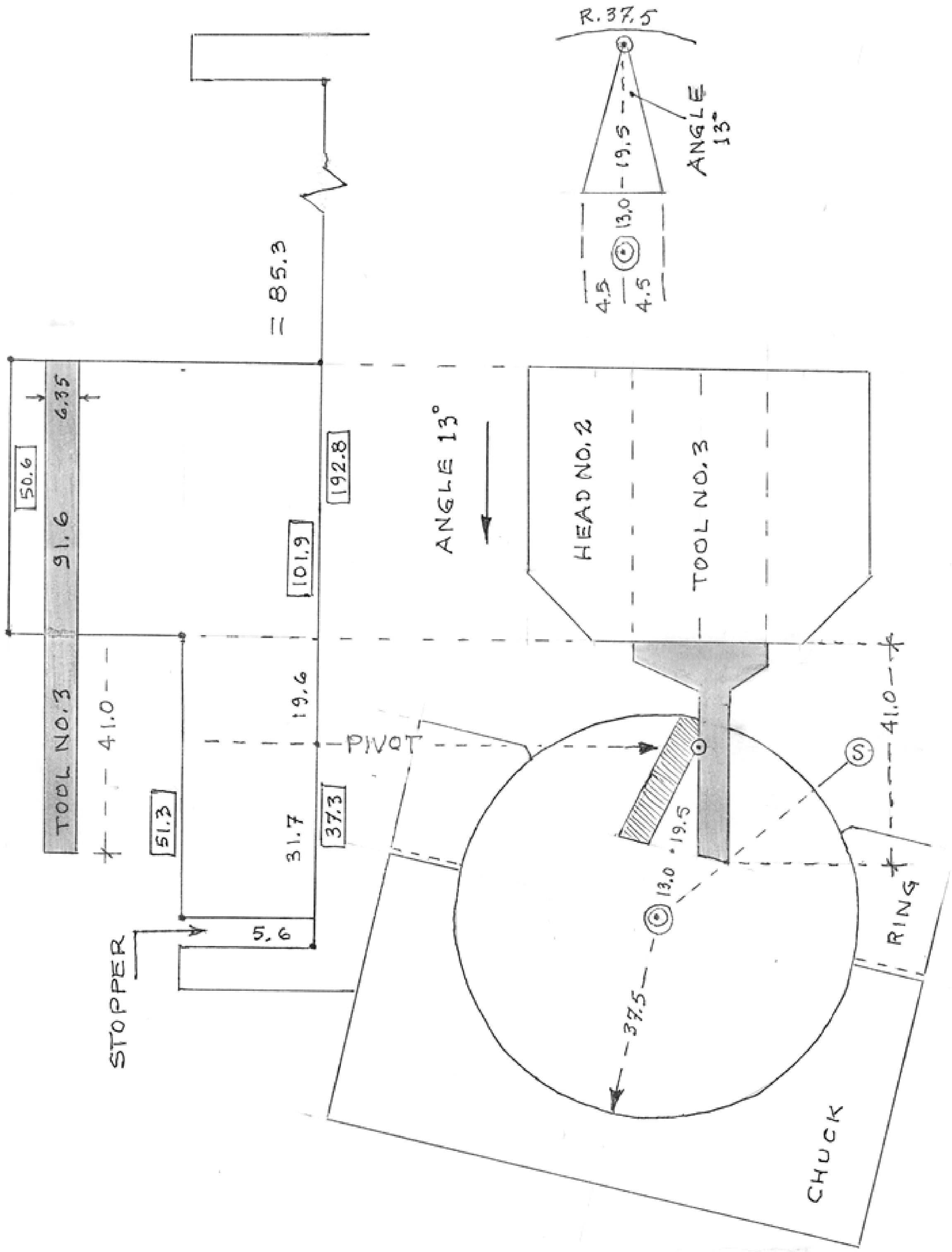




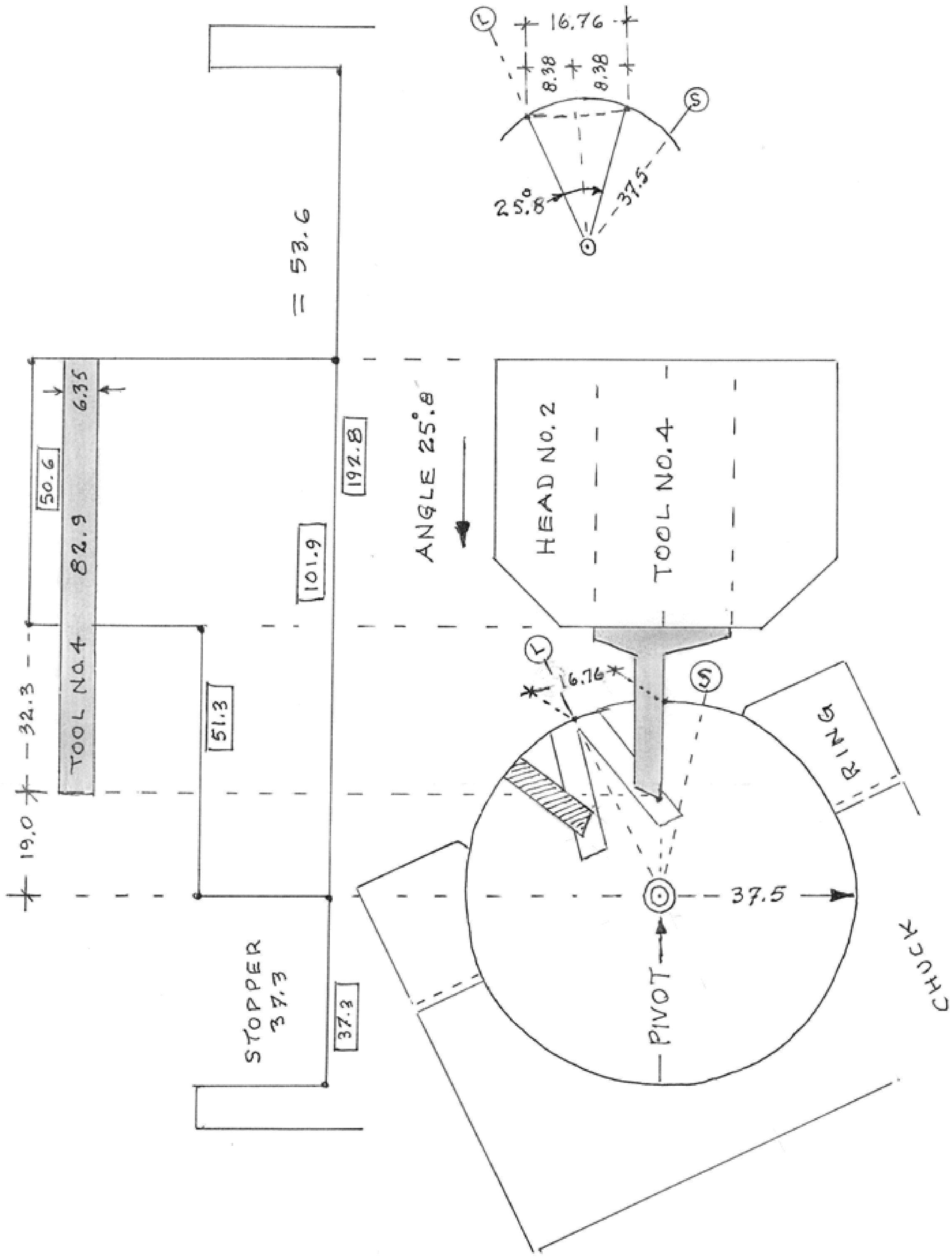
COMBLIKE TOOL
TO CUT ALL 3
SHELLS IN ONE
PASS (OPTIONAL).

PLUG

ITEM NO. 8

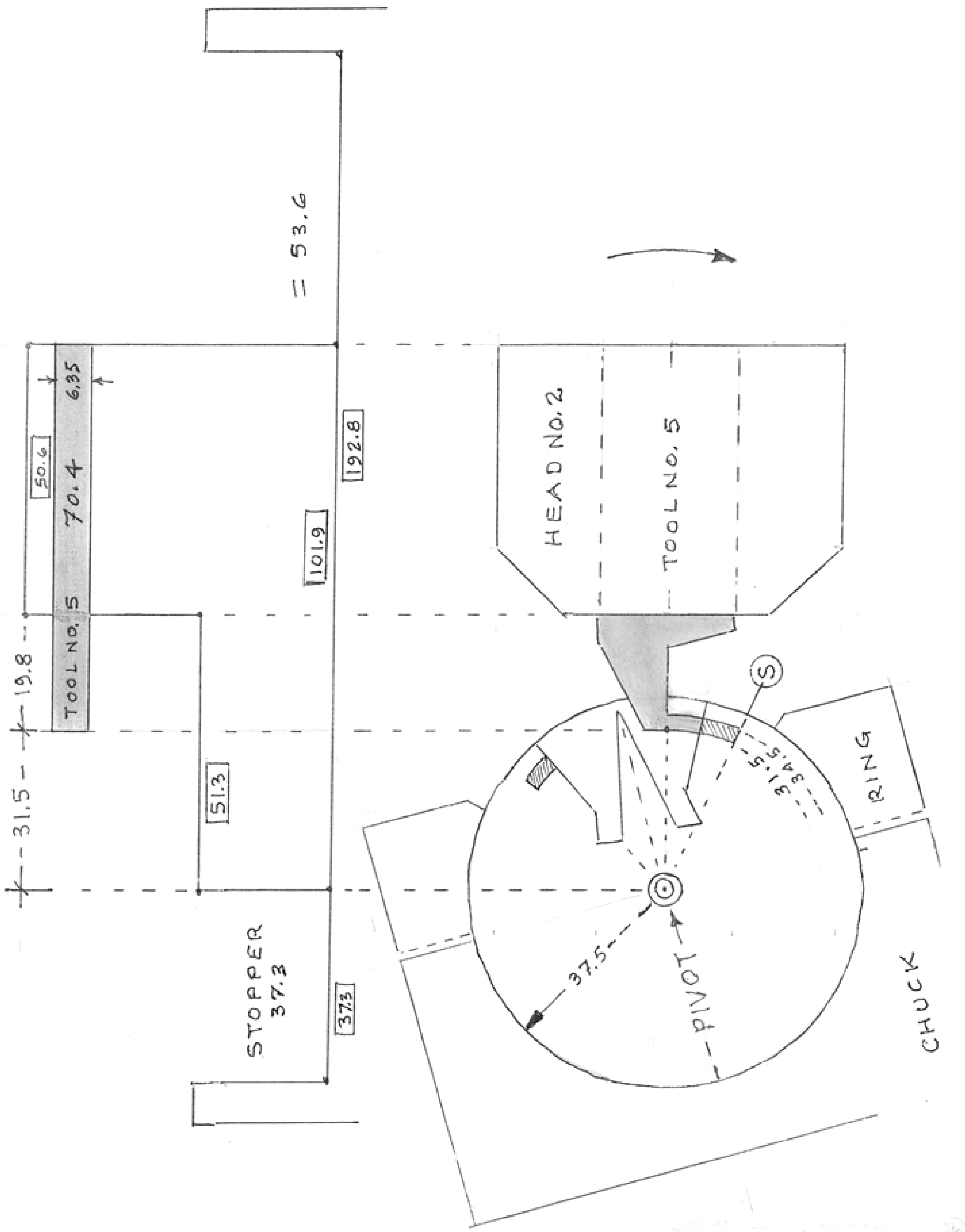

R.37.5
ANGLE 13°
19.5
13.0
4.5
4.5
≈ 85.3
6.35
50.6
91.6
192.8
101.9
ANGLE 13°
HEAD NO.2
TOOL NO.3
TOOL NO.3
41.0
19.6
PIVOT
51.3
31.7
37.3
5.6
STOPPER
19.5
13.0
41.0
RING
37.5
CHUCK

ITEM NO.9



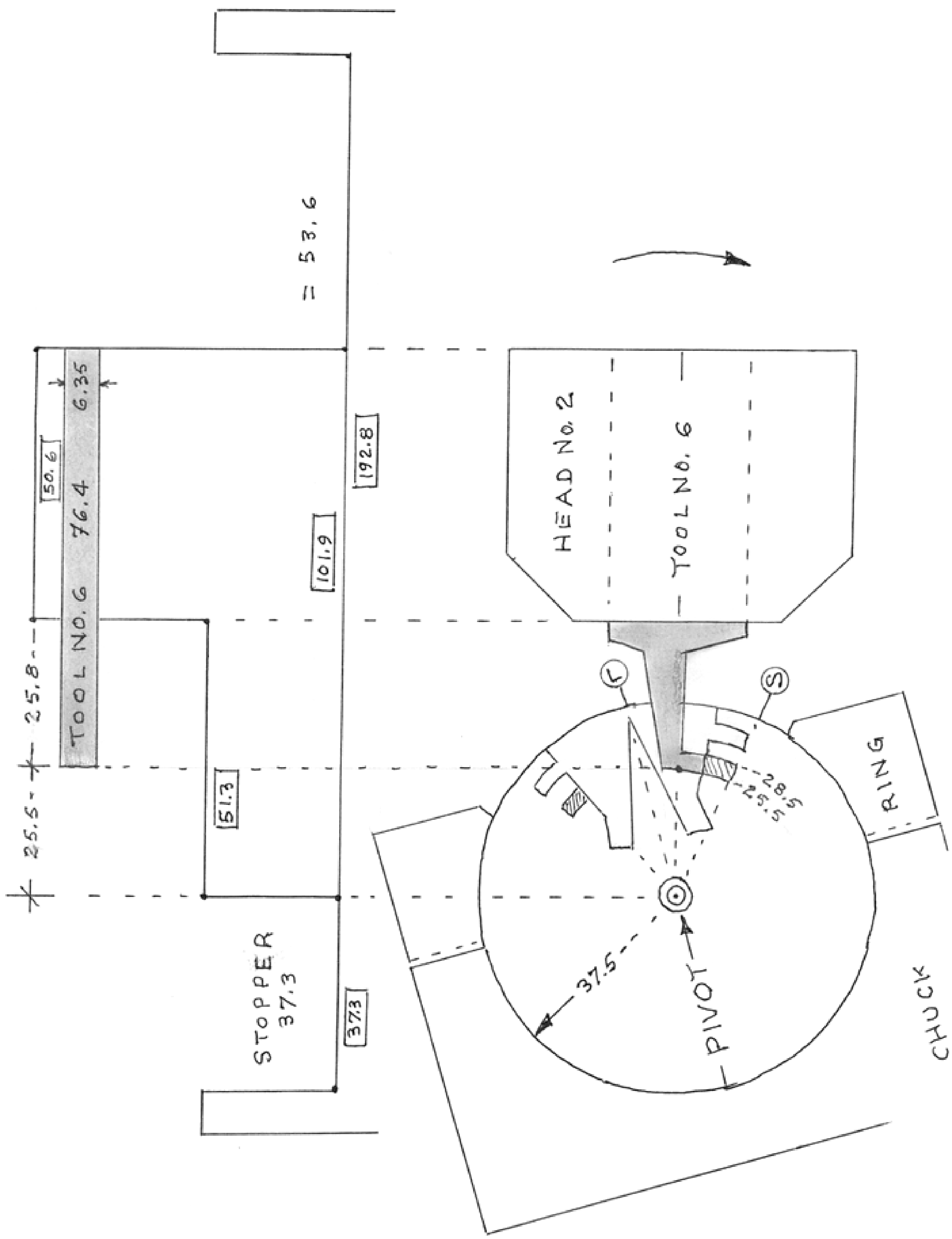
= 53.6
16.76
8.38
8.38
L
S
25.8°
37.5
ANGLE 25°.8
HEAD NO.2
TOOL NO.4
192.8
101.9
50.6
82.9
6.35
TOOL No.4
32.3
51.3
19.0
16.76
STOPPER
37.3
37.3
PIVOT
37.5
RING
CHUCK

ITEM NO. 10

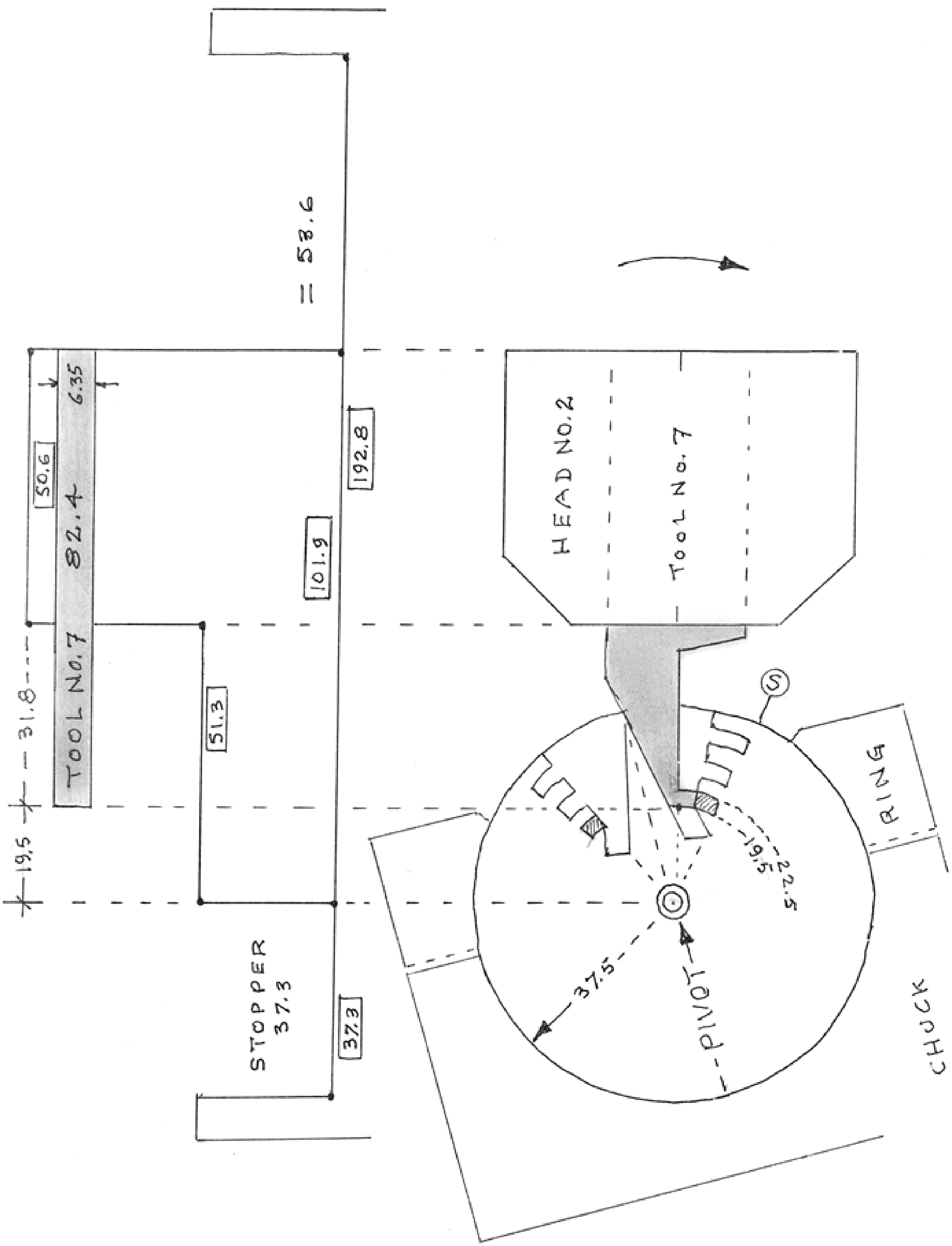


= 53.6
192.8
101.9
51.3
37.3
50.6
70.4
6.35
TOOL NO. 5
19.8
31.5
STOPPER
37.3
HEAD NO. 2
TOOL NO. 5
S
RING
PIVOT
37.5
CHUCK

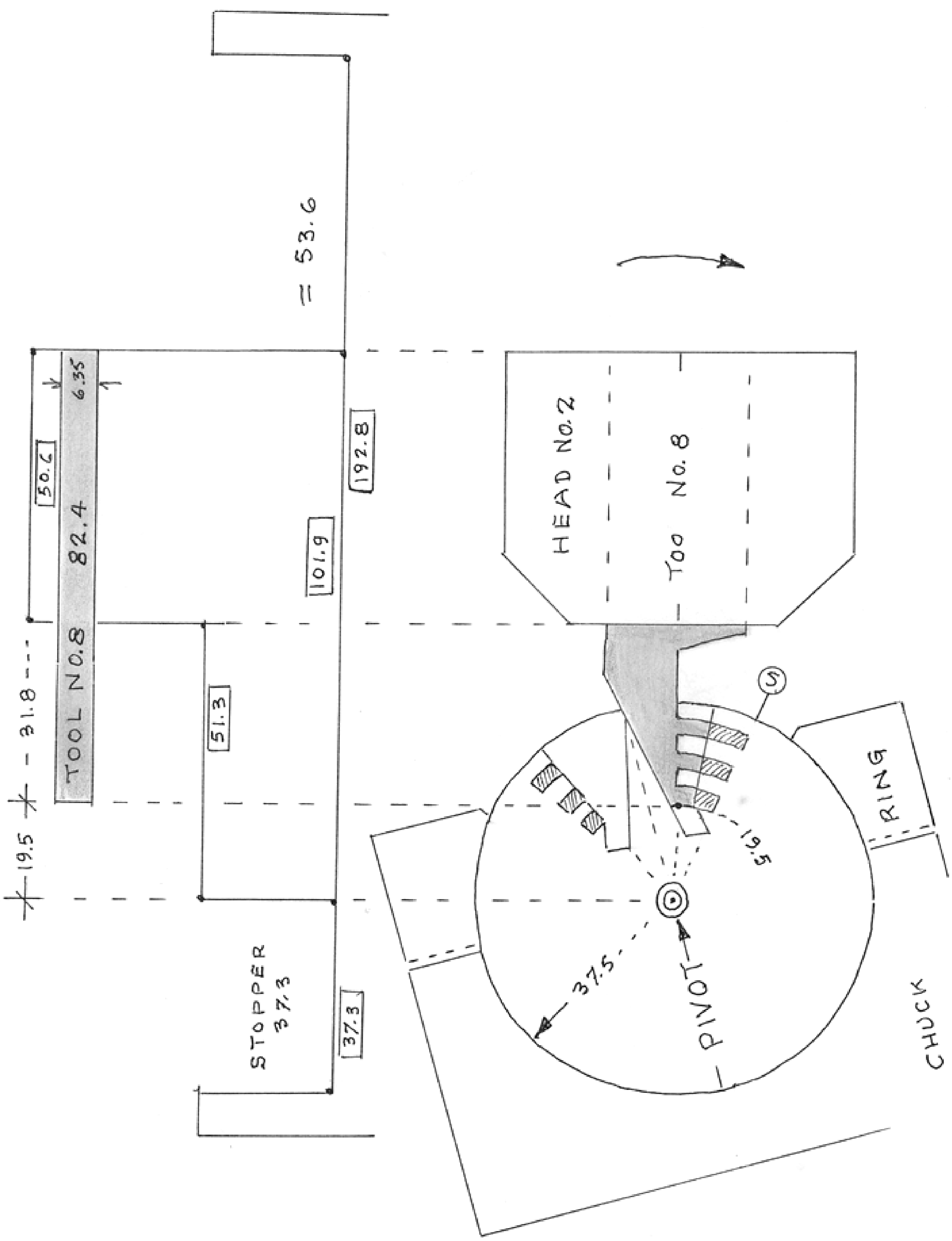
ITEM NO. 11


= 53.6
HEAD NO. 2
TOOL NO. 6
6.35
50.6
76.4
TOOL NO. 6
192.8
101.9
25.8
25.5
51.3
L
S
28.5
25.5
RING
STOPPER
37.3
37.3
37.5
PIVOT
CHUCK

ITEM NO.12


= 53.6
HEAD No.2
TOOL No.7
TOOL No.7
82.4
50.6
6.35
192.8
101.9
51.3
31.8
19.5
STOPPER
37.3
37.3
RING
CHUCK
PIVOT
37.5
19.5
22.5
S

ITEM NO. 13


= 53.6
192.8
101.9
51.3
37.3
STOPPER
37.3
TOOL No.8
82.4
50.6
6.35
19.5
31.8
HEAD No.2
Too No.8
5
RING
19.5
37.5
PIVOT
CHUCK

Tour de Force

C - Spiked dodecahedron in 2 concentric spheres in a dodecahedron

Claude LETHIECQ

~ *Sequence of operations* ~

Item

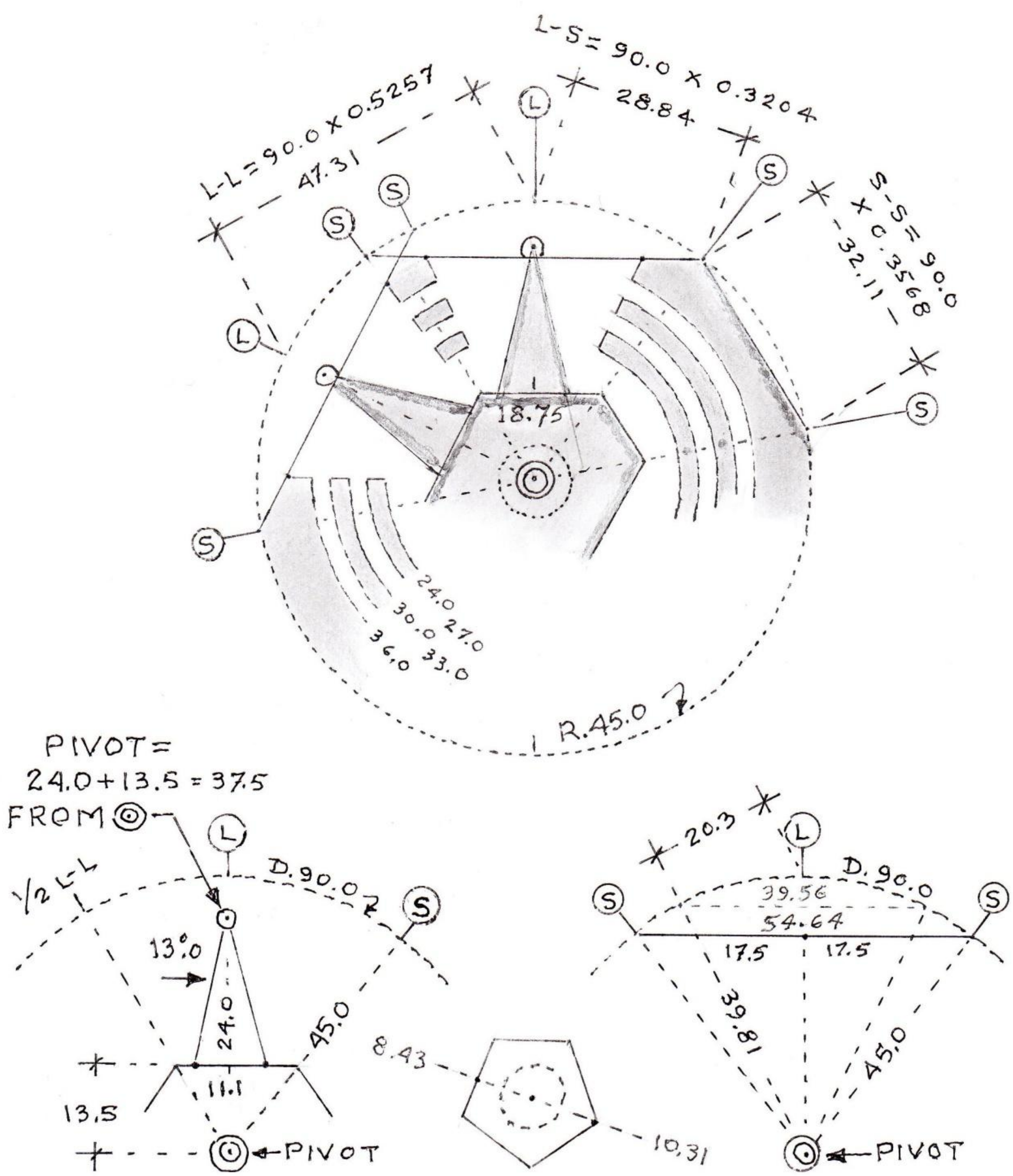
1. Draw cross-section
2. Make tool N°1 and chuck
3. Make tool N°2 and chuck ring
4. Make tool N°3 and approximate stopper
5. Same as item N°4 for tool N°4
6. Same as item N°4 for tool N°5
7. Same as item N°4 for tool N°6
8. Same as item N°4 for tool N°7
9. Optional : same as item N°4 for tool N°8 to replace tools N°5, 6 and 7
10. Draw cross-section on simulation plate (as exactly as you can with 4H well sharpened pencil)
11. With head N°2 on sphere jig refine your tools, once refined, what you see your tool do on the plate is what it will cut in the wood
12. Turn sphere Ø90.0, mark 12 Ⓛ points and 20 Ⓢ (dodecahedron)
13. Set sphere in the chuck, align an Ⓛ point, set the ring, set jig pivot at ⦾, set jig stopper against left side of jig base, back off jig and set a spacer of 37.5 against stopper, reset jig against spacer and lock in place
14. Mark R.20.3 around Ⓛ point
15. Angle jig rotation at 11.3° and use tool N°3
16. Remove 37.5 spacer and reset jig against jig stopper to be back on ⦾ pivot
17. Angle jig rotation at 26.1° and use tool N°4
18. Unlock jig rotation and use tool N°5
19. Same as item 18 for tool N°6

20. Same as item 18 for tool N°7
21. Optional : same as item 18 for tool N°8 instead of tools N°5, 6 and 7
22. Set plugs (see item N°10)
23. With double face tape, glue cap and turn it to the diameter of the sphere so as to always have a full sphere in the chuck (see item N°10)
24. Loosen ring and align another Ⓛ point and repeat item N° 13 to 21 until all 12 openings are done (skip “plug” and “cap” for the last opening).

ITEM NO. 1

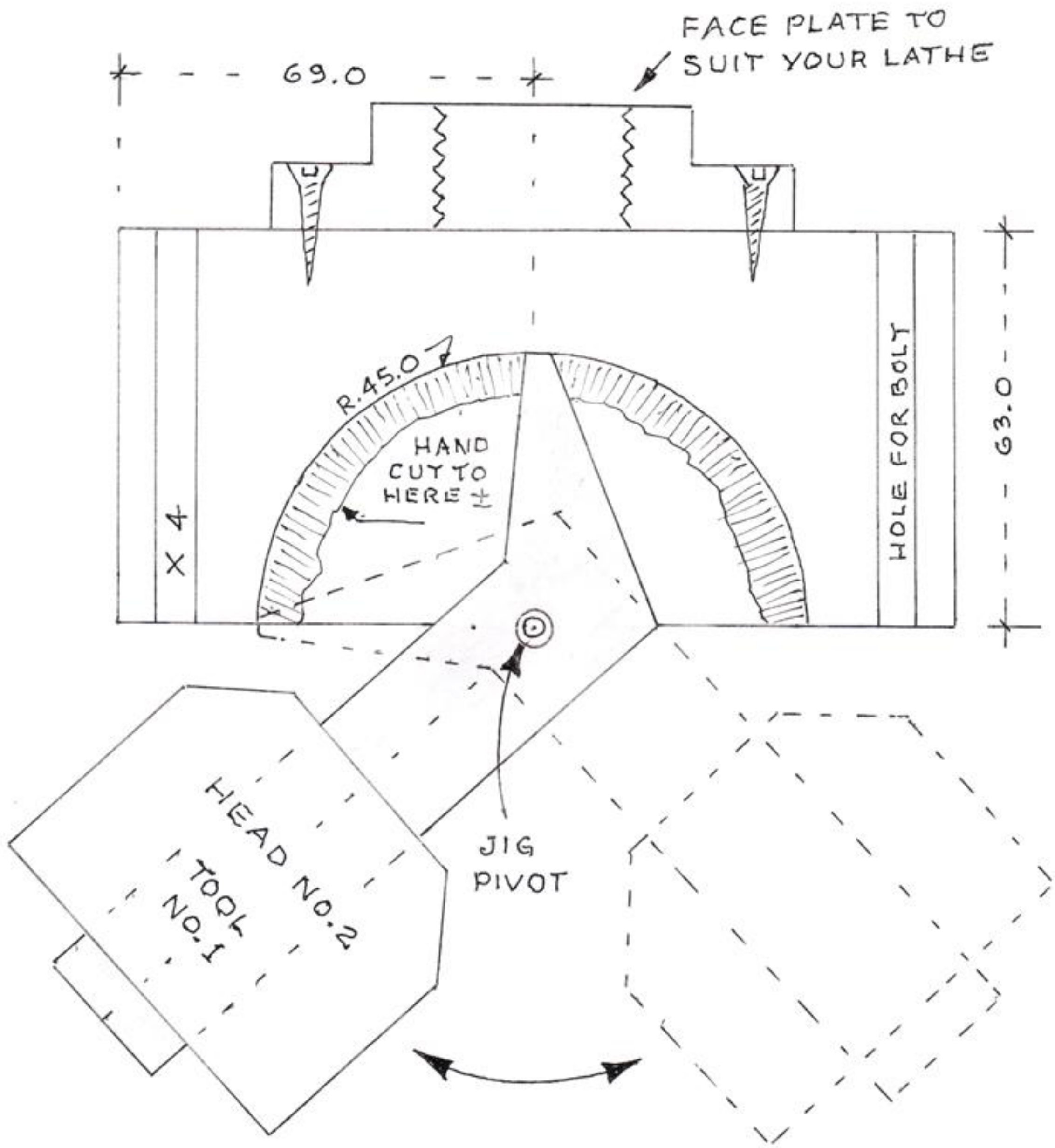
~ cross-section ~

Spiked dodecahedron in 2 concentric spheres in a dodecahedron

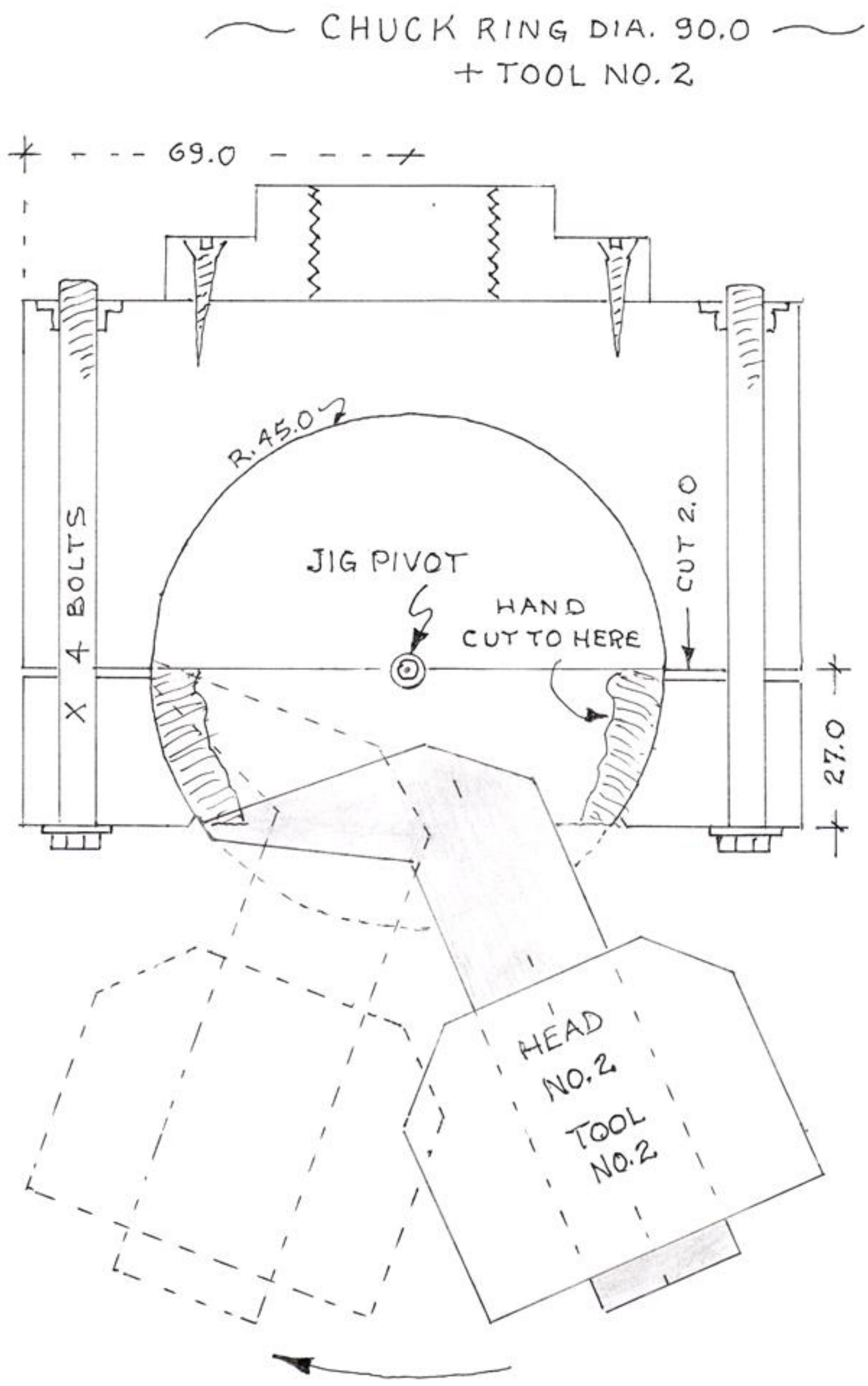


ITEM NO. 2

CHUCK DIA. 90.0
+ TOOL NO. 1

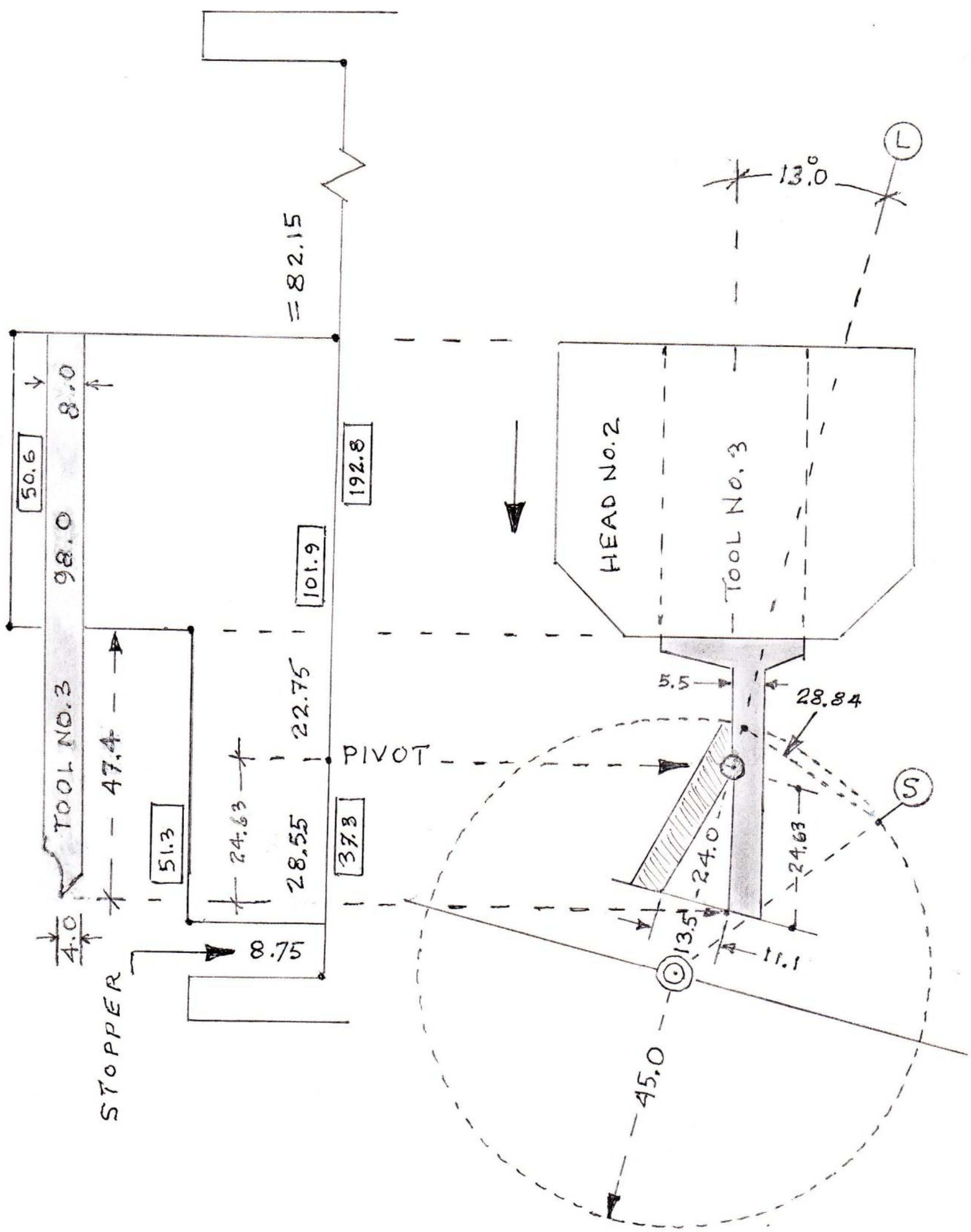


ITEM NO. 3

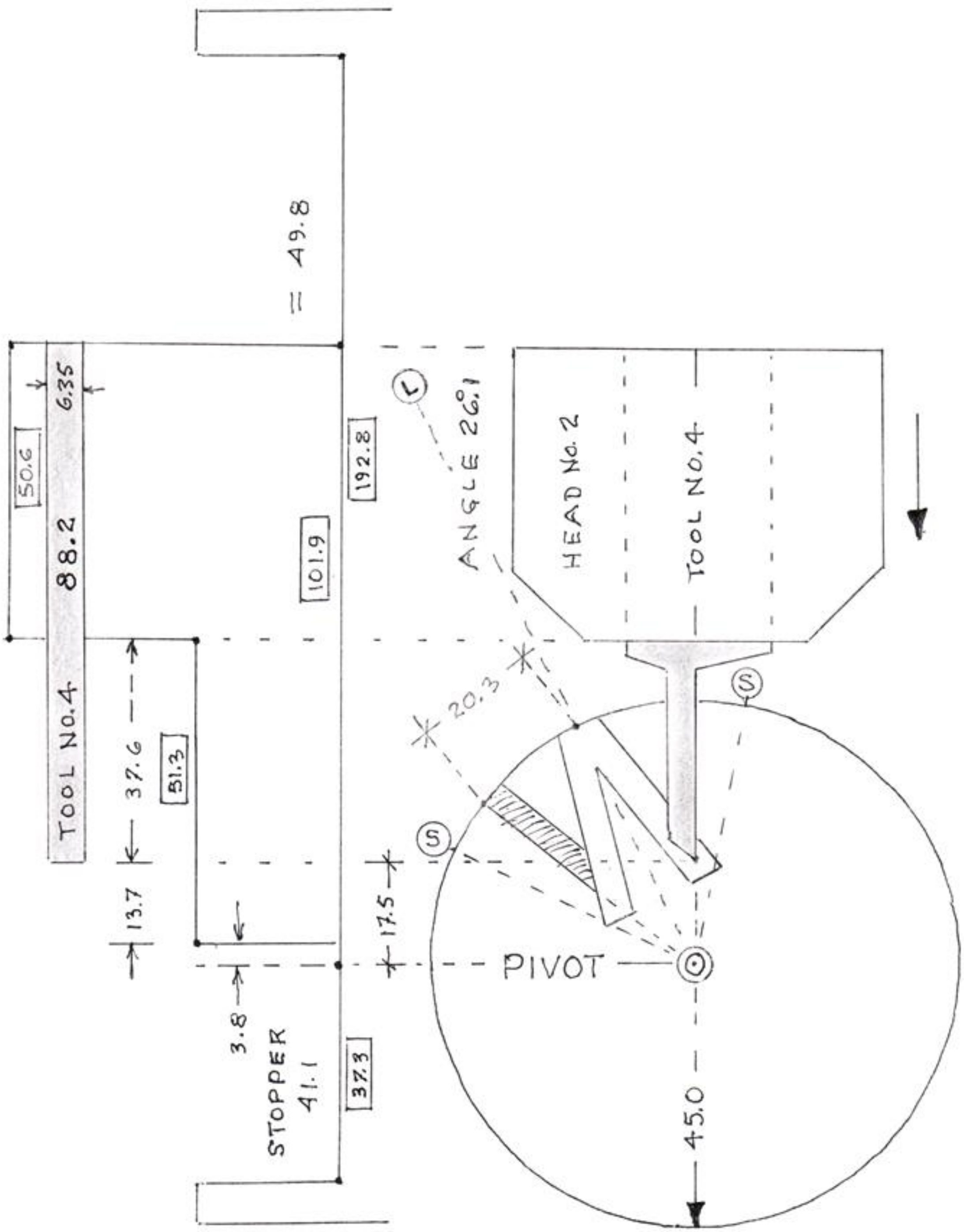


~ CHUCK RING DIA. 90.0 ~
+ TOOL NO. 2
69.0
R.45.0
X 4 BOLTS
JIG PIVOT
HAND CUT TO HERE
CUT 2.0
27.0
HEAD NO. 2
TOOL NO. 2

ITEM NO.4

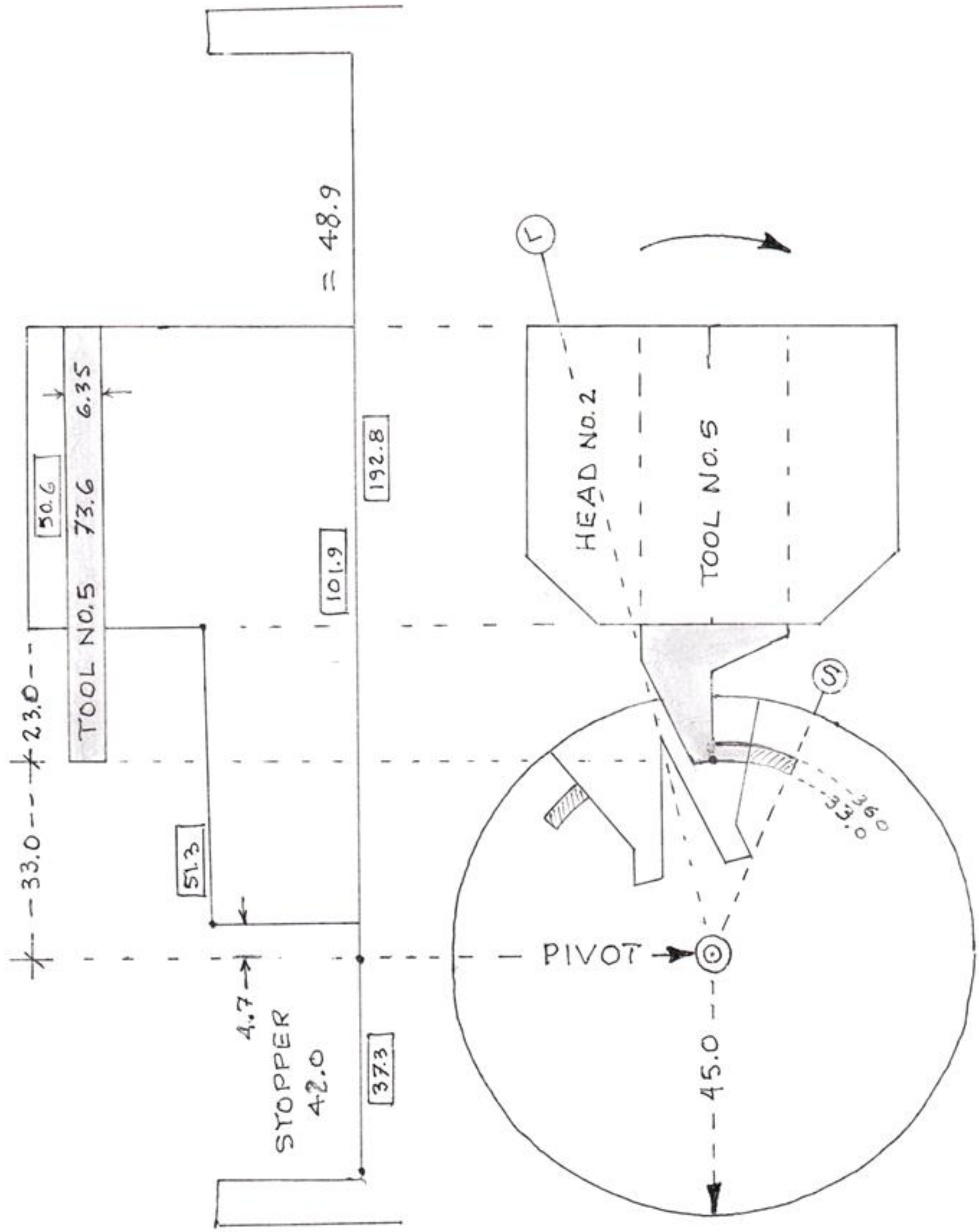

13.0°
L
=82.15
HEAD NO.2
TOOL NO.3
TOOL NO.3
50.6
8.0
98.0
192.8
101.9
47.4
22.75
PIVOT
5.5
28.84
S
24.63
28.55
51.3
37.3
24.0
24.63
13.5
11.1
4.0
8.75
STOPPER
45.0

ITEM NO.5



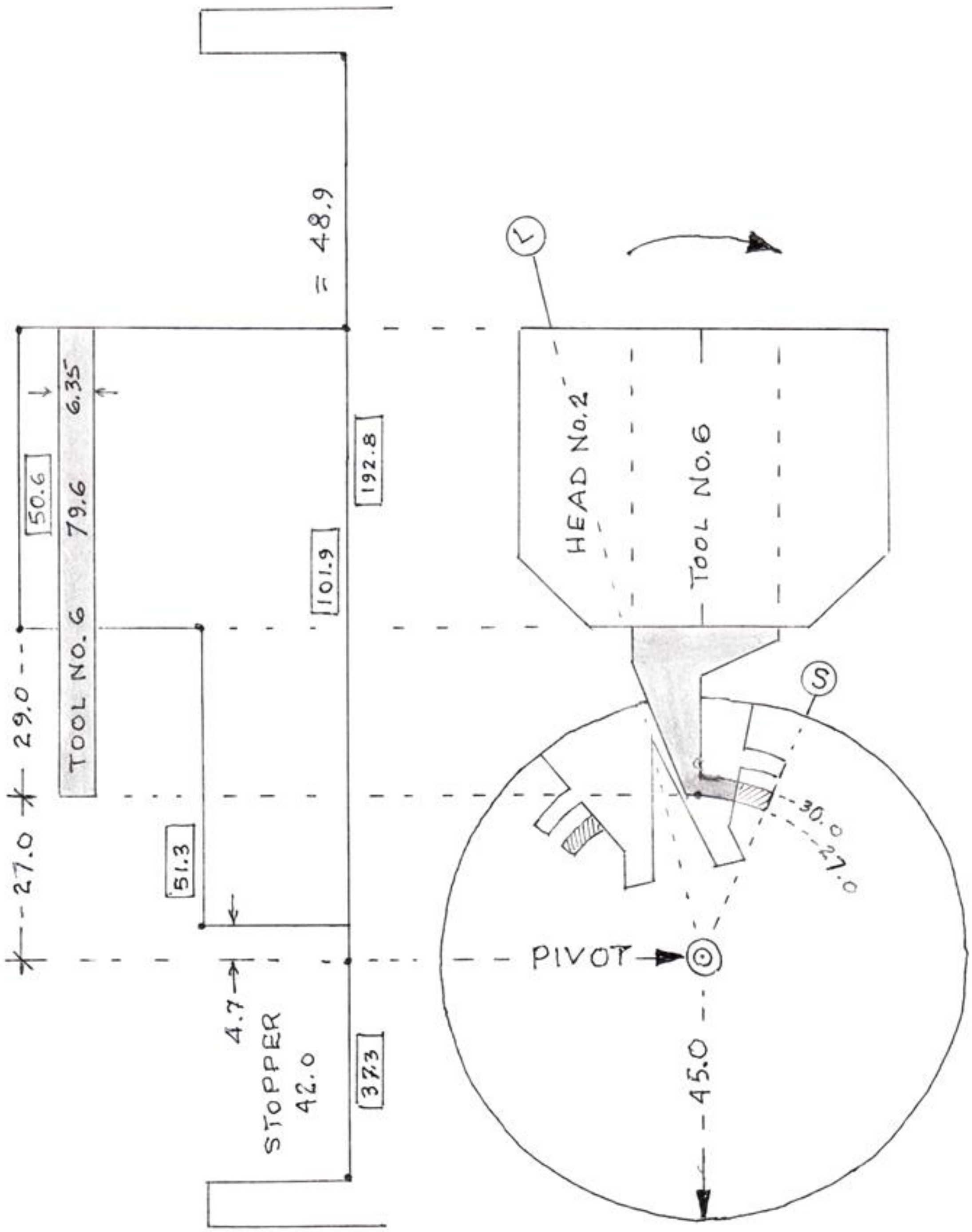
= 49.8
6.35
50.6
88.2
192.8
101.9
ANGLE 26.1°
HEAD No. 2
TOOL No. 4
TOOL No.4
37.6
31.3
20.3
13.7
17.5
PIVOT
3.8
STOPPER
41.1
37.3
45.0

ITEM NO. 6



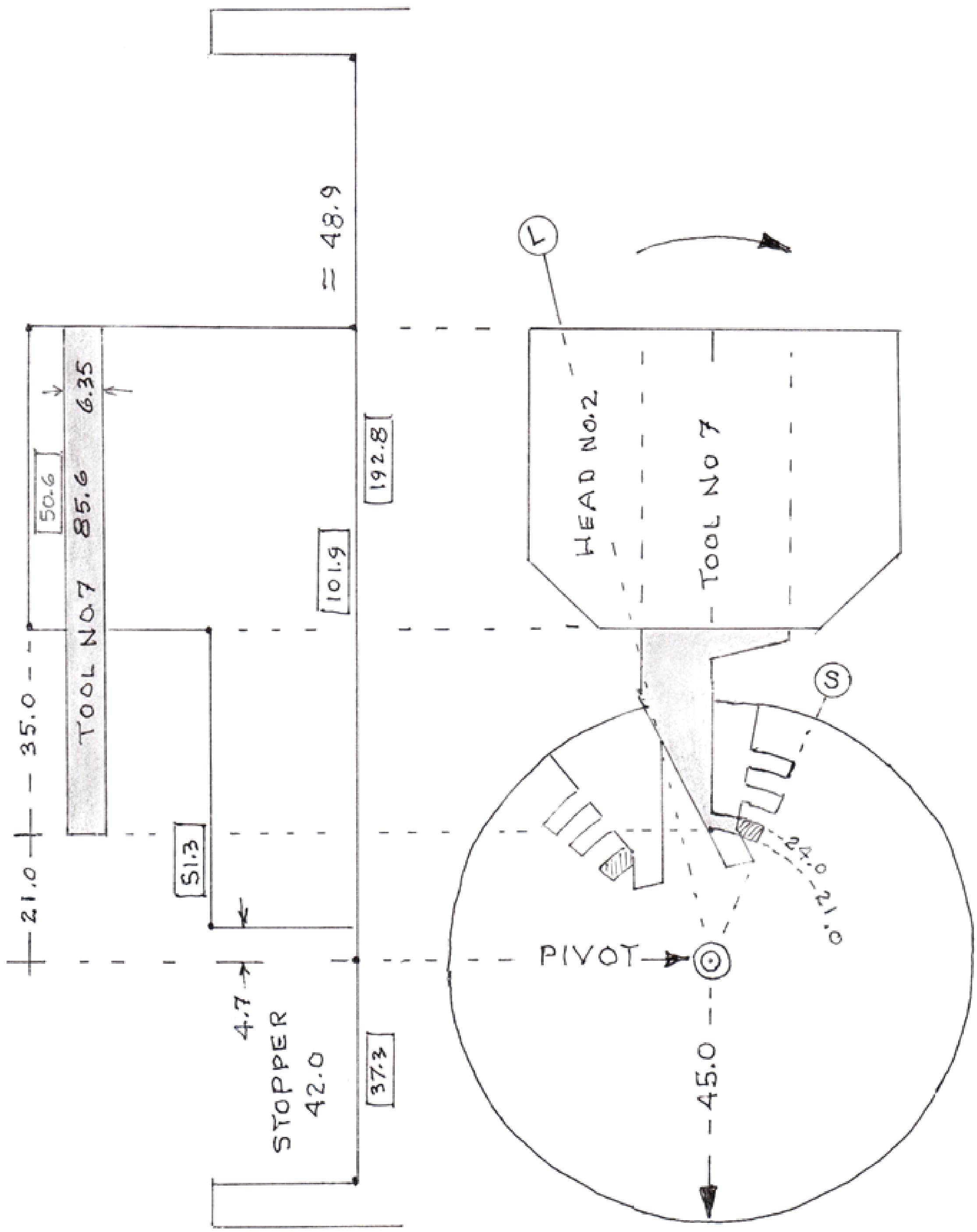
= 48.9
L
HEAD No.2
TOOL No.5
192.8
50.6
TOOL No.5 73.6
6.35
101.9
23.0
33.0
S
36.0
33.0
51.3
PIVOT
4.7
STOPPER
42.0
37.3
45.0

ITEM NO. 7



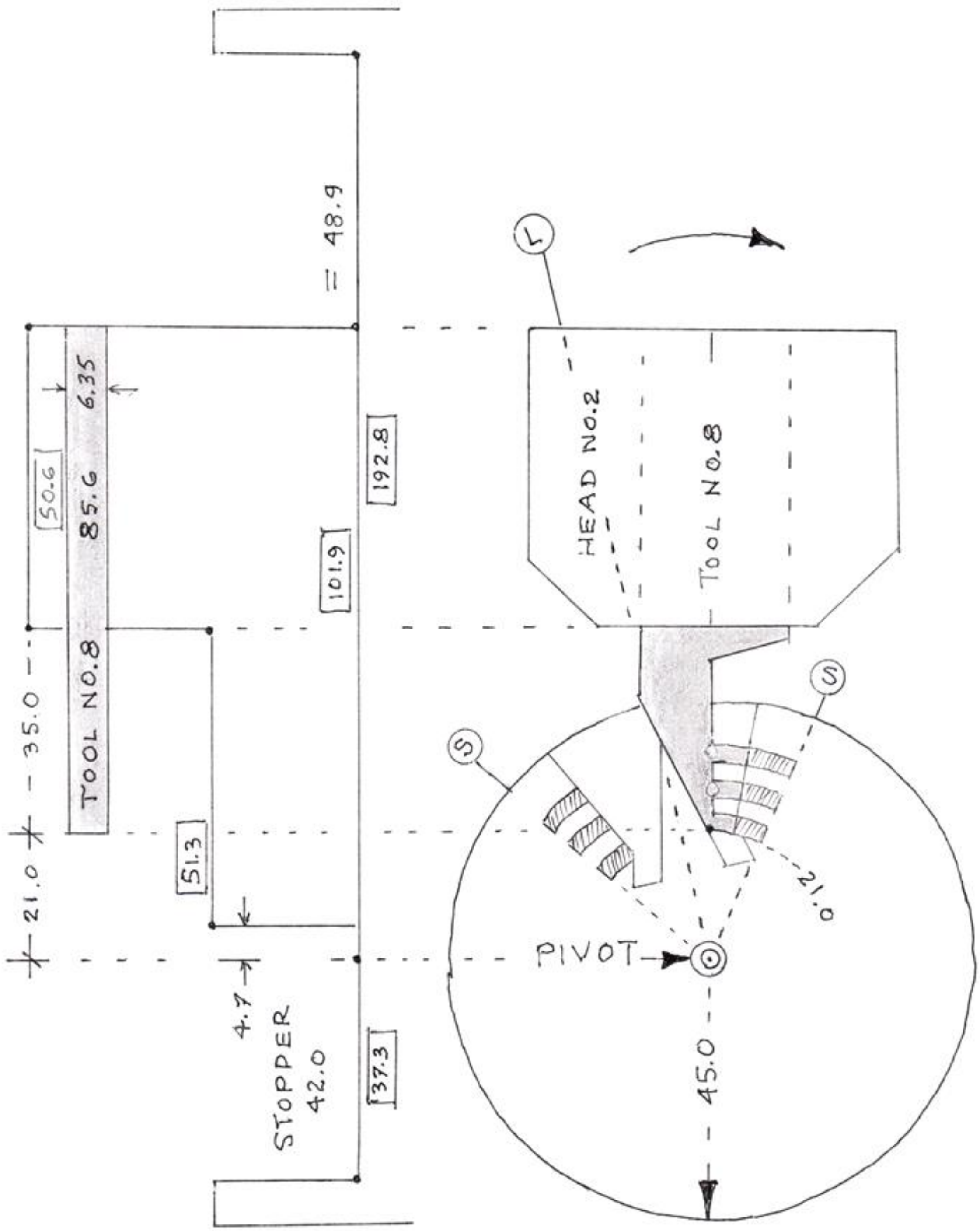
48.9
HEAD No.2
TOOL No.6
192.8
101.9
50.6
79.6
6.35
TOOL NO. 6
29.0
27.0
51.3
30.0
27.0
PIVOT
4.7
STOPPER
42.0
37.3
45.0
L
S

ITEM NO. 8



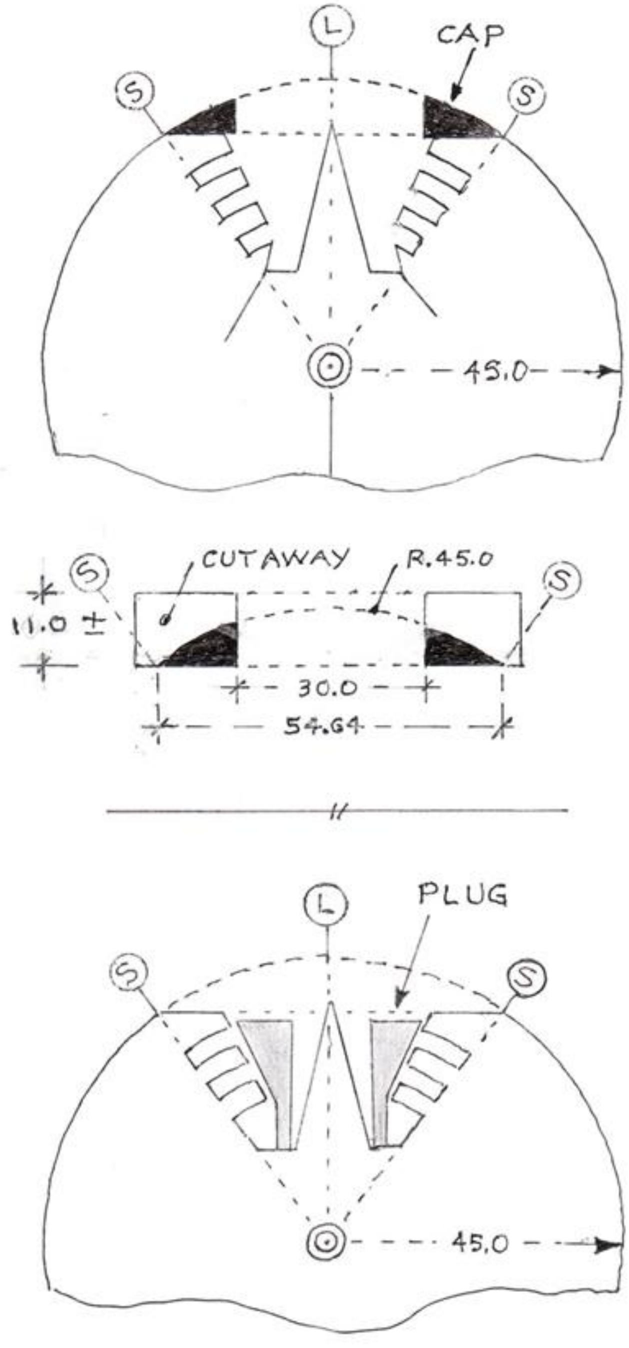
= 48.9
L
HEAD No.2
TOOL No 7
192.8
6.35
50.6
85.6
TOOL No.7
101.9
35.0
S
21.0
51.3
24.0
21.0
PIVOT
4.7
STOPPER
42.0
37.3
45.0

ITEM NO. 9


= 48.9
L
HEAD NO.2
TOOL NO.8
192.8
101.9
50.6
85.6
6.35
TOOL NO.8
35.0
21.0
51.3
S
S
21.0
PIVOT
4.7
STOPPER
42.0
37.3
45.0

ITEM NO. 10

~ CAP AND PLUG ~



Tour de Force

D - “Supernova”

Claude LETHIECQ

~ Sequence of operations ~

Item

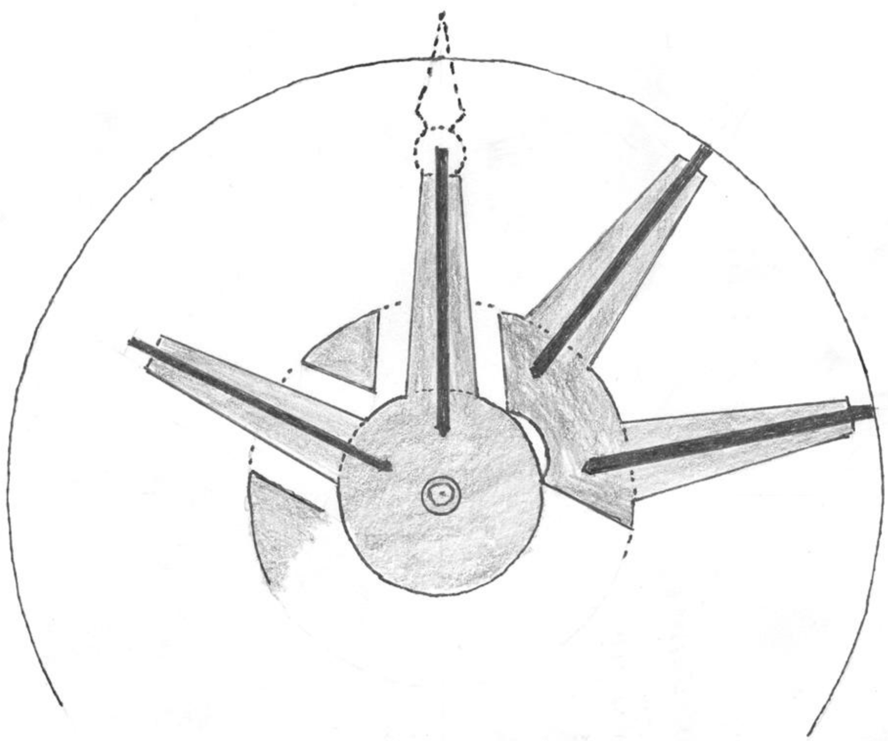
1. Use same chuck and ring as for “Surprise”
2. Draw cross-section
3. Turn sphere Ø134.0
4. Mark sphere with dodecahedron divisions. Identify 12 “L” points in circle Ⓛ and 20 “S” points in $\boxed{S}$
5. Details of Ⓛ spikes (12)
6. Drill hole Ø25.4 and 16.6 deep at edge of hole
7. Hand cut wings
8. Drill Ø2.4 hole 40.0 deep and set rod (finishing nail), let it stick out 3.6 mm
9. With a 12.7 mm (1/2 inch) plug cutter, cut 32.0 deep
10. Use tool N°1 (see item N°23, tool N°1 in sphere jig)
11. Make 12 plugs for all Ⓛ points
12. Set plugs
13. Repeat items 5 to 10 and 12 till all 12 Ⓛ points are done
14. Details of Ⓢ spikes (20)
15. Drill hole Ø25.4 and 2.4 deep at edge of hole
16. Drill Ø2.4 hole, 40 mm deep and set rod (finishing nail with no head), let it stick out 3.6
17. With a 12.7 (1/2 inch) plug cutter, cut 30.0 deep
18. Use tool N°2 (see item N°24, tool N°2 in sphere jig)
19. Make 20 plugs for all Ⓢ points
20. Set plugs
21. Repeat items 14 to 18 and 20 till all 20 Ⓢ points are done
22. You now have a sphere with 32 openings, each with a spike inside so you must destroy the sphere carefully to reveal the completed piece. Then add finals of your choice
23. and 24. Each tool position in sphere jig

ITEM N°2

~ Supernova ~

2 points Star inside and through a 20 points star (detached)

<u>cross-section</u>



L-L = D.134.0 x 0.5257 = 70.44

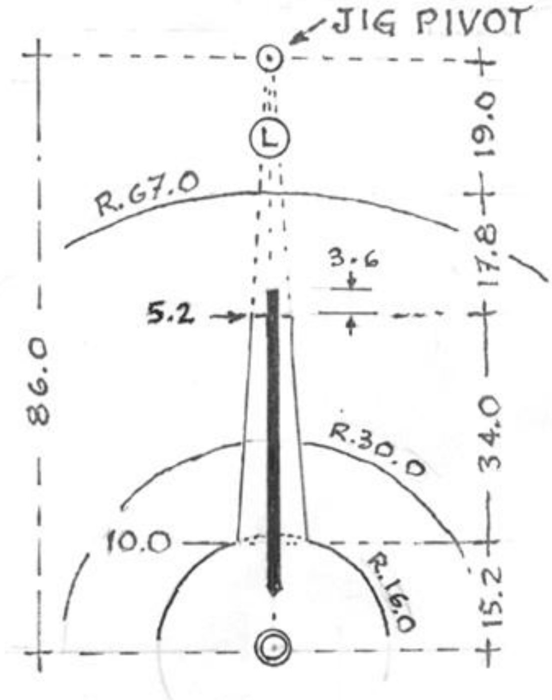
L-S = D.134.0 x 0.32O4 = 42.98

S-S = D.134.0 x 0.3568 = 47.81

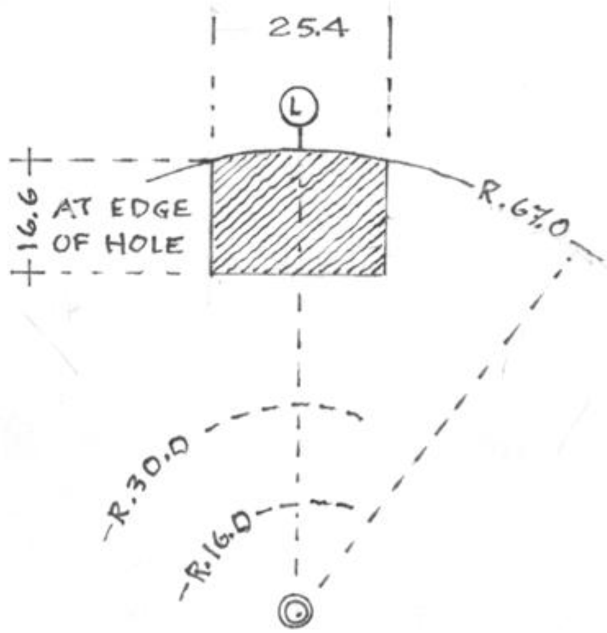
Dodecahedron divisions

ITEM NO.5

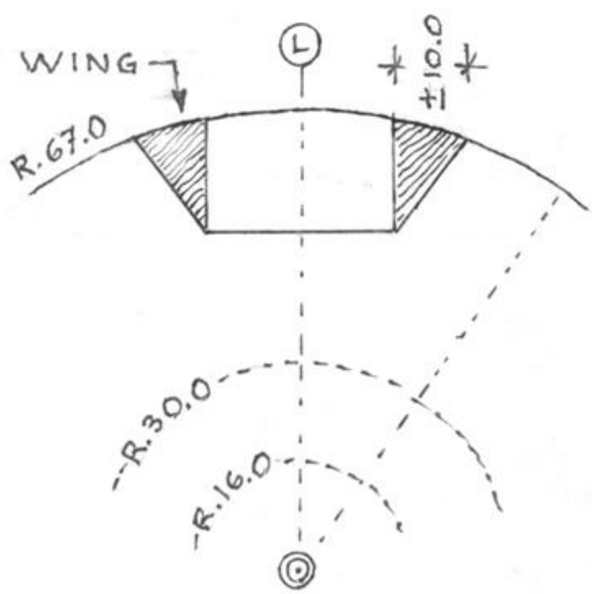
DETAILS OF L SPIKES



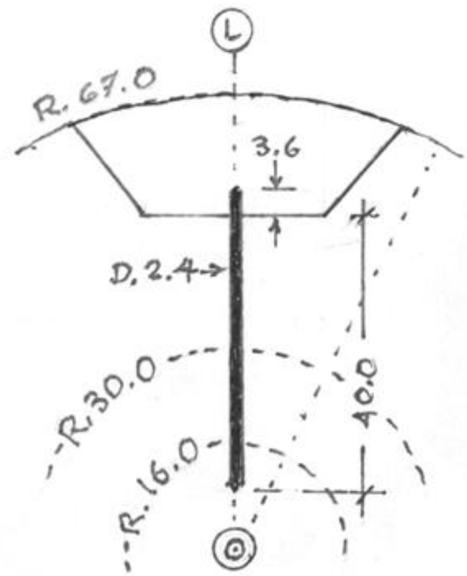
ITEM NO.6



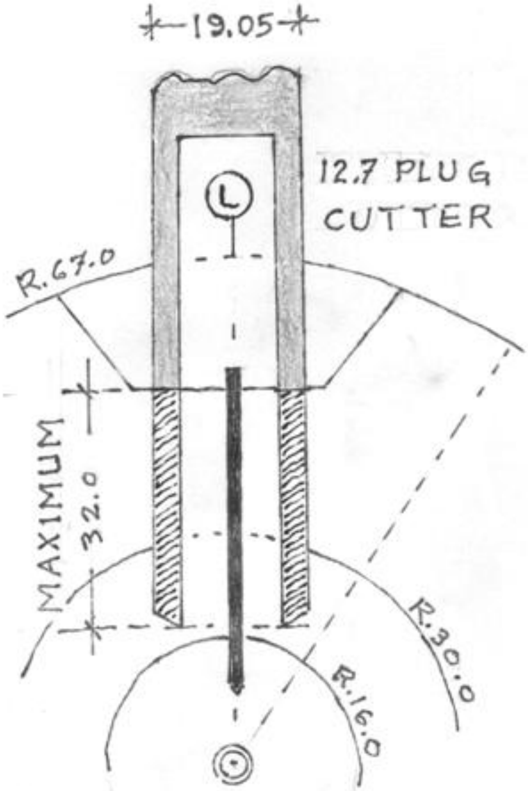
ITEM NO.7



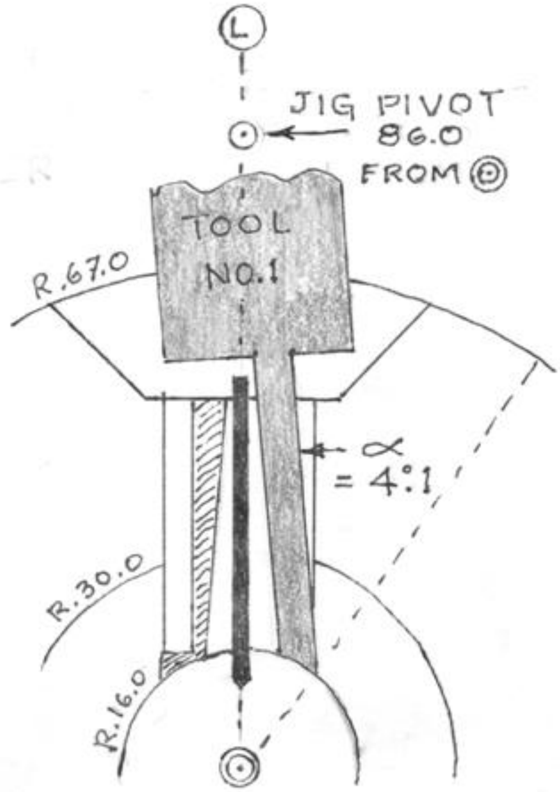
ITEM NO.8



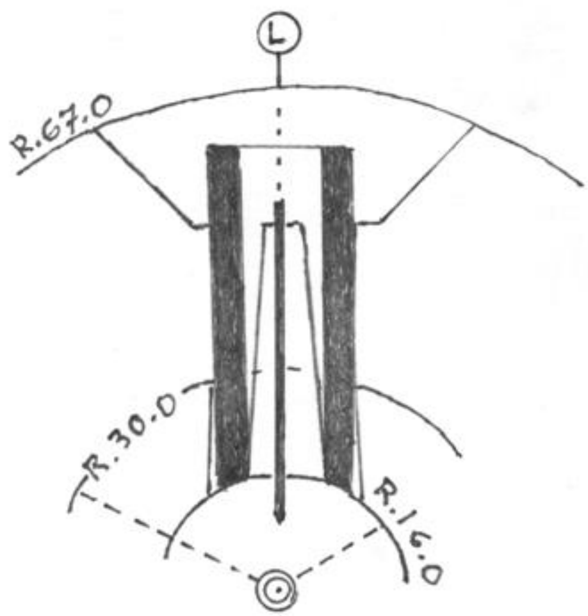
ITEM NO.9



ITEM NO.10

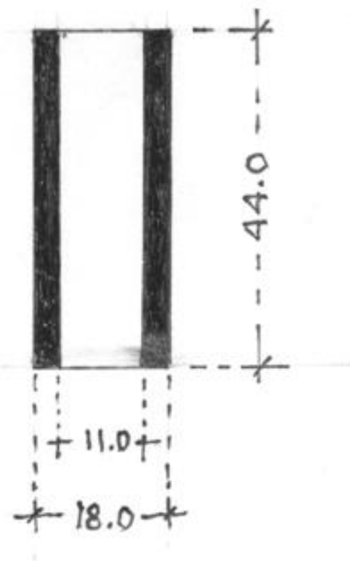


ITEM NO.12



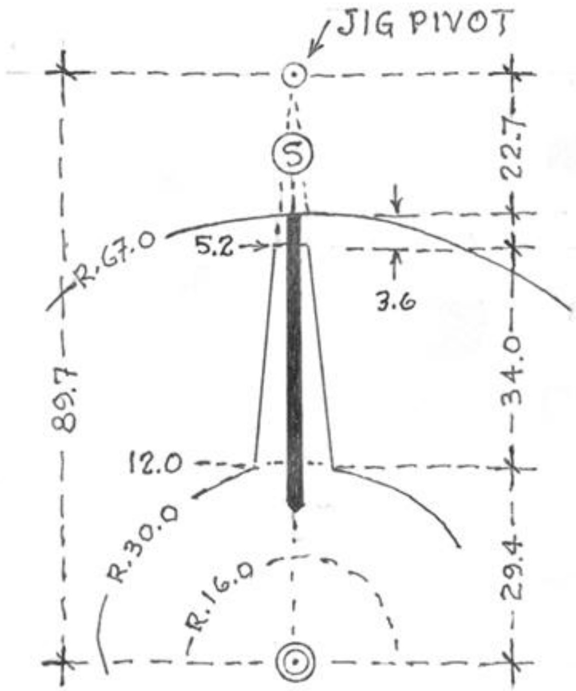
ITEM NO.11

12 PLUGS FOR L

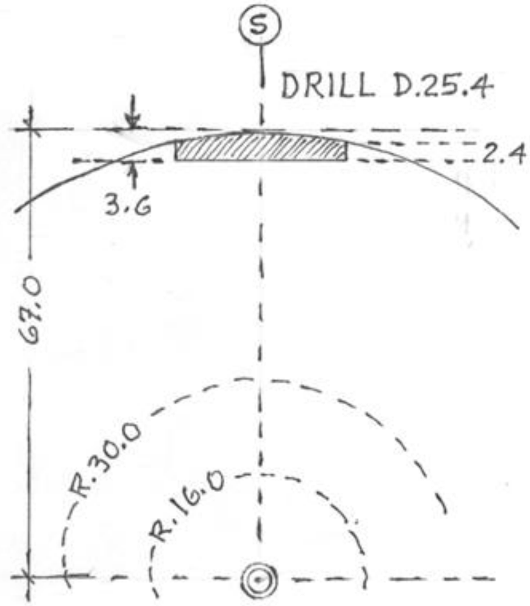


ITEM NO.14

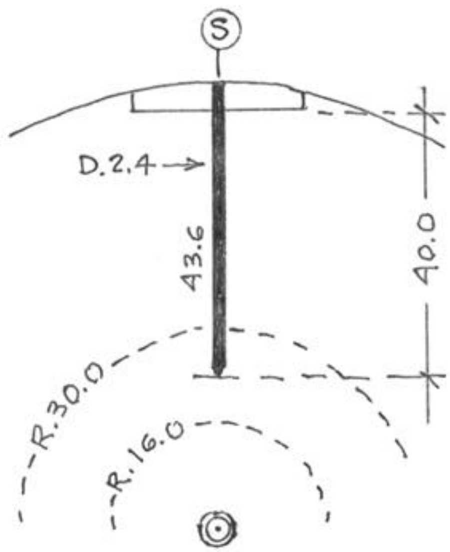
DETAILS OF Ⓢ SPIKES



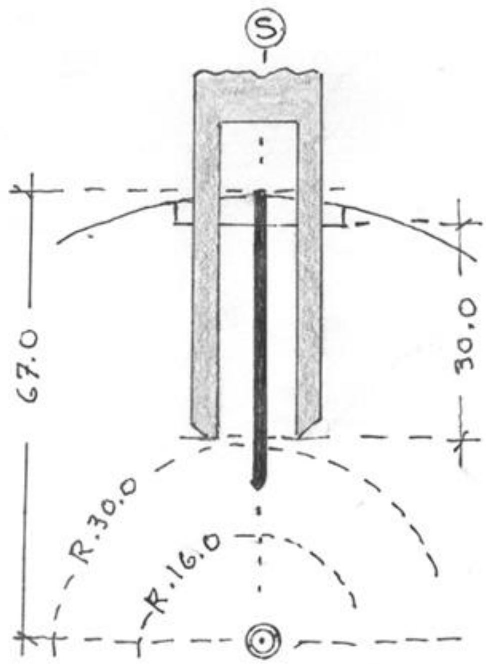
ITEM NO.15



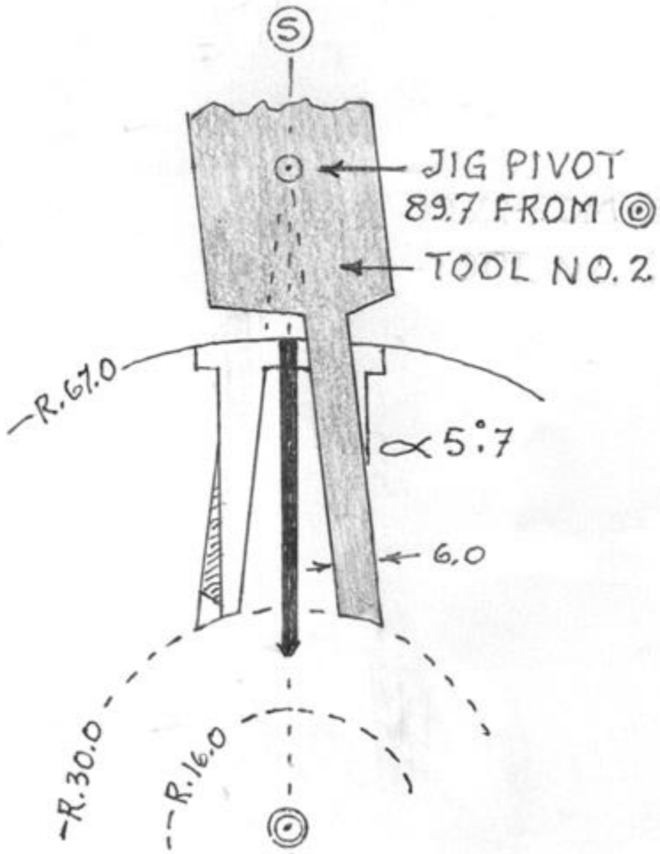
ITEM NO.16



ITEM NO.17

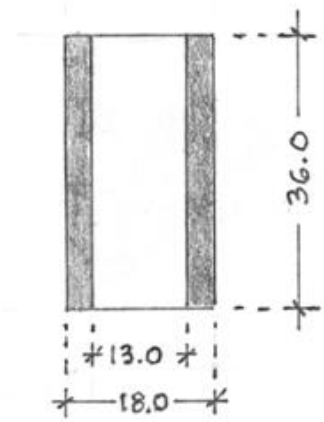


ITEM NO.18

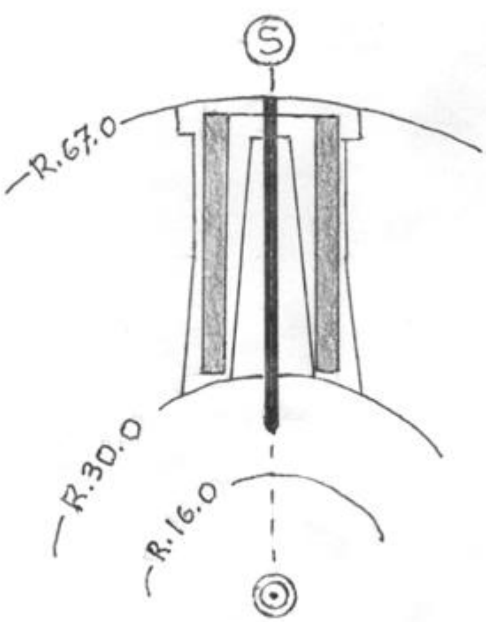


ITEM NO.19

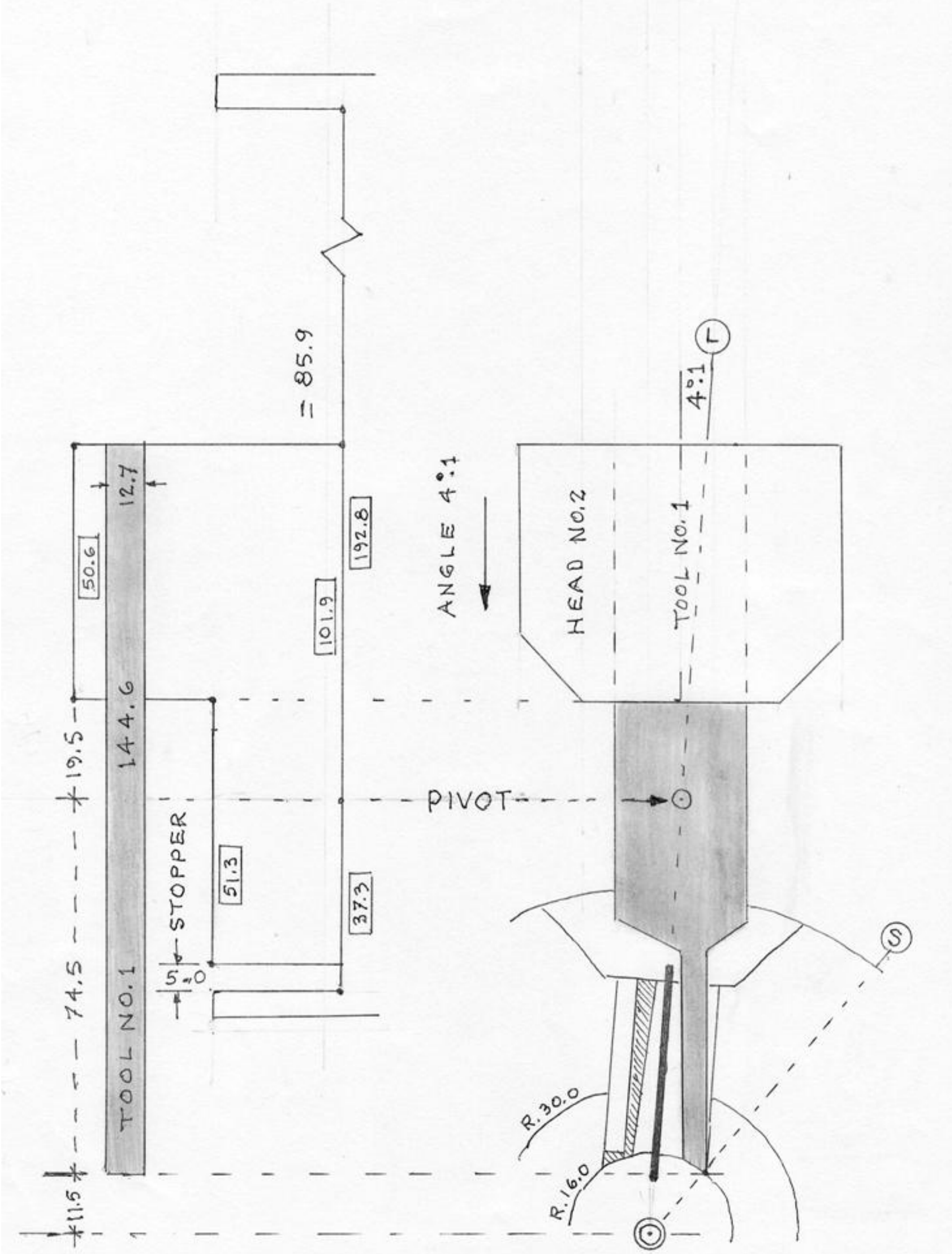
20 PLUGS FOR S



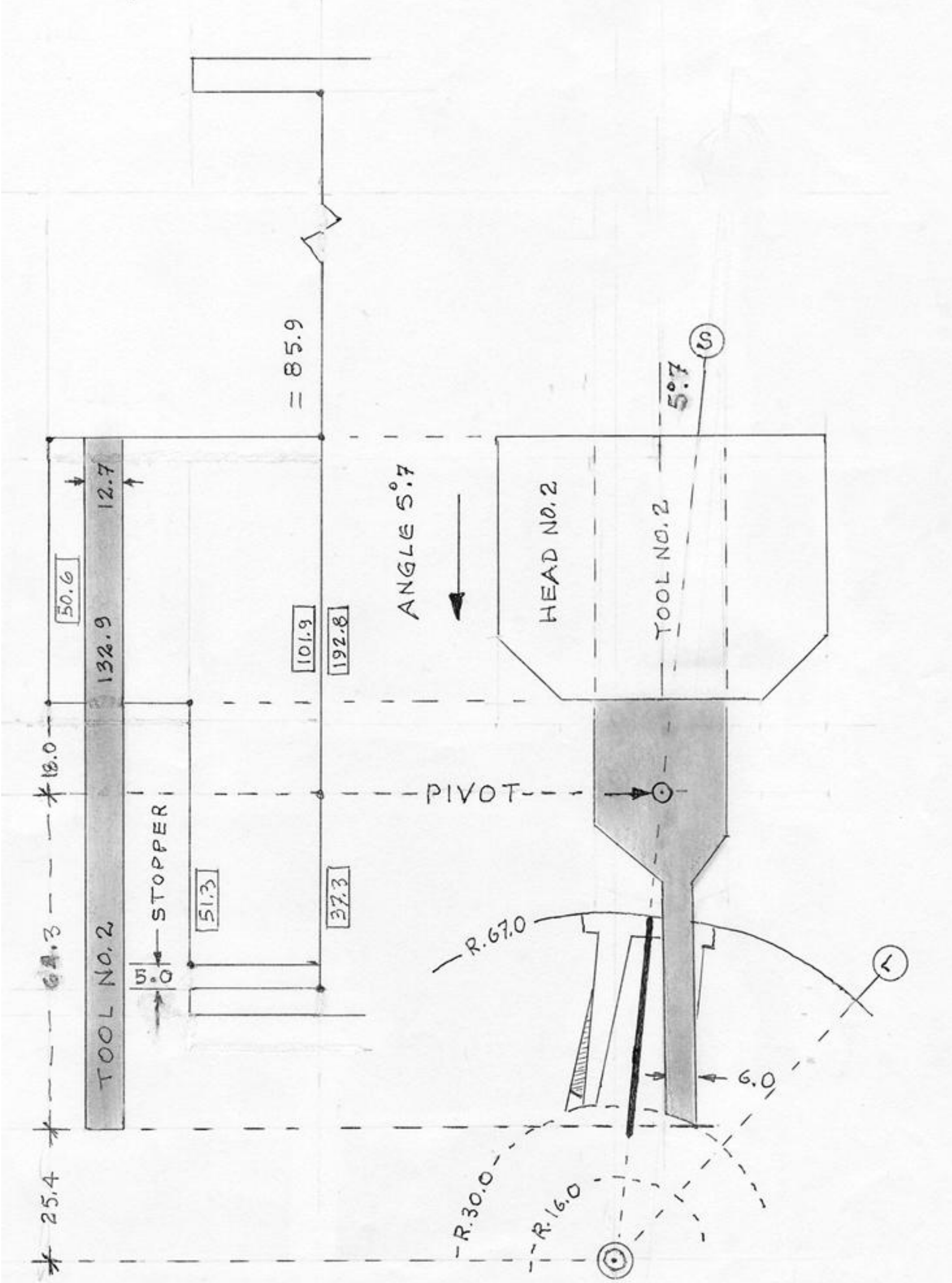
ITEM NO.20



ITEM NO. 23


= 85.9
TOOL NO.1
144.6
12.7
50.6
192.8
101.9
19.5
74.5
11.5
STOPPER
51.3
37.3
5.0
ANGLE 4°1
HEAD NO.2
TOOL NO.1
4°1
PIVOT
R.30.0
R.16.0

ITEM NO. 2+



85.9
5°7
ANGLE 5°7
HEAD NO. 2
TOOL NO. 2
12.7
50.6
132.9
101.9
192.8
18.0
PIVOT
STOPPER
51.3
37.3
5.0
TOOL NO. 2
R.67.0
6.0
25.4
R.30.0
R.16.0

Tour de Force

E - "Cyclope"

Claude LETHIECQ

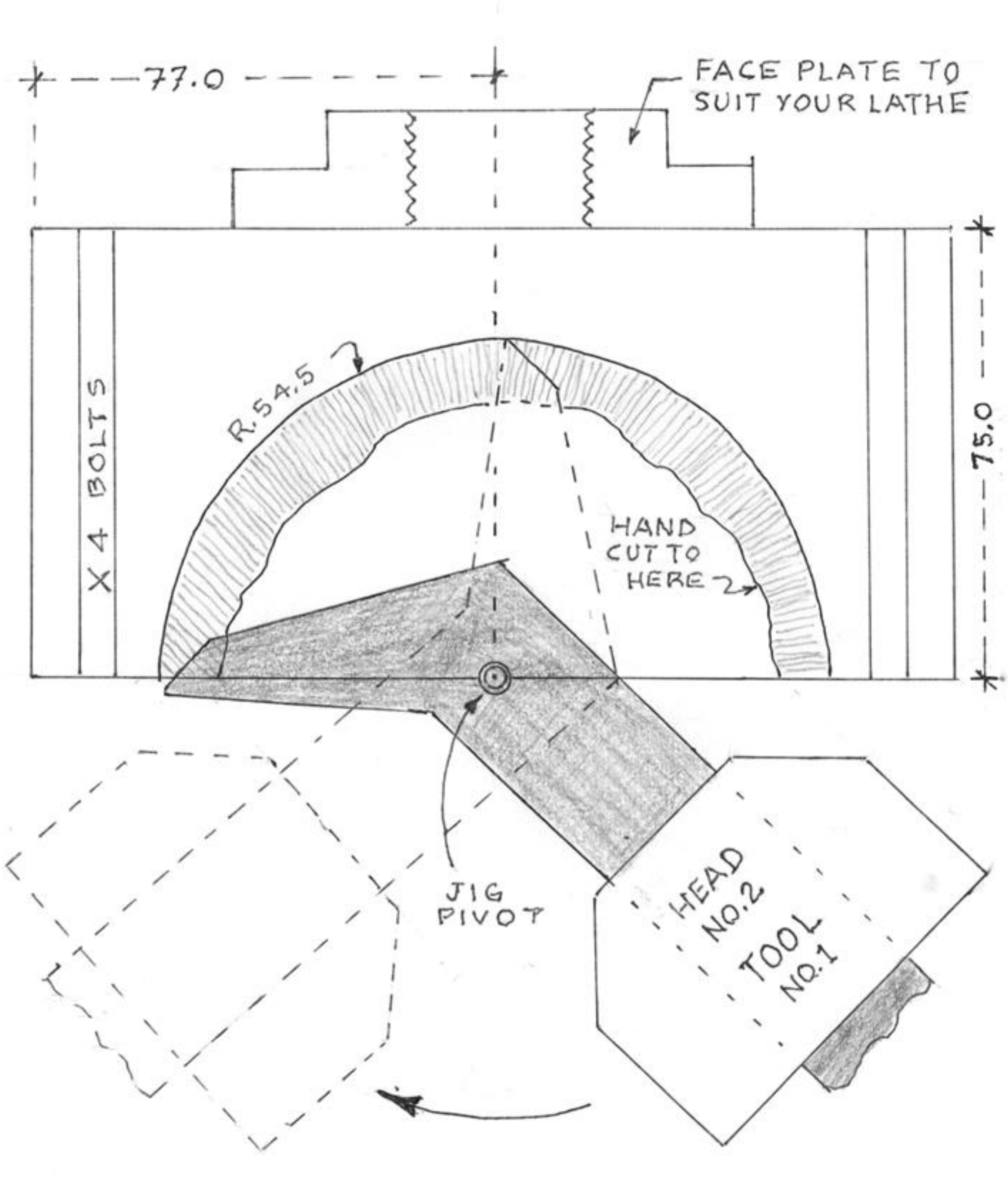
~ Sequence of operations ~

Item

1. Make tool N°1 and chuck
2. Make tool N°2 and chuck ring
3. Draw cross-section
4. Turn sphere Ø109.0 , mark opening as per item N°5
5. Details to cut Ø90.0 sphere
6. Tools N°3 and 4
7. Tool N°5
8. Tool N°6
9. Tool N°7 (in 2 parts). Set part 2 in the opening made by tool N°3 leaving threaded holes accessible to superimpose part 1 and set screws and to cut Ø90.0 sphere
10. Mark 12 Ⓛ points (dodecahedron divisions) on Ø90.0 sphere
11. Make and glue cup to replace wood cut by tool N°7
12. Make secondary ring as per drawing
13. Set R.54.5 sphere in chuck, set chuck ring, align an Ⓛ point and set secondary ring
14. A- cut flat B- set nail C- use plug cutter
15. Make and use tools N°8 and 9
16. Make and use tool N°10 and plug
17. Repeat items 13 to 16 until all 12 Ⓛ points are done
18. Remove plugs and clean all wax
19. Make and set 12 round finals
20. Each tool position in sphere jig : 20-1 to 20-8

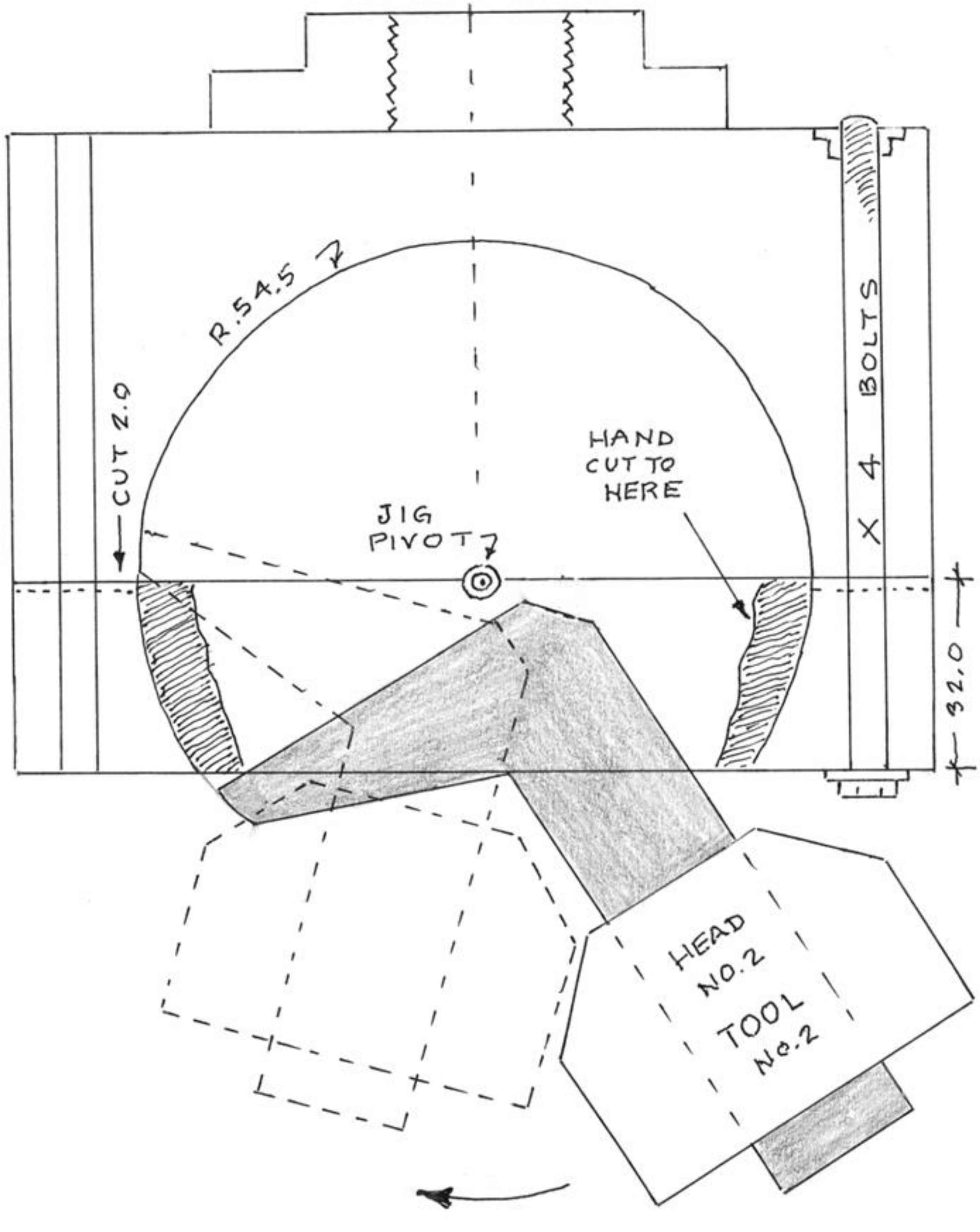
ITEM NO. 1

~ CHUCK ~



ITEM NO. 2

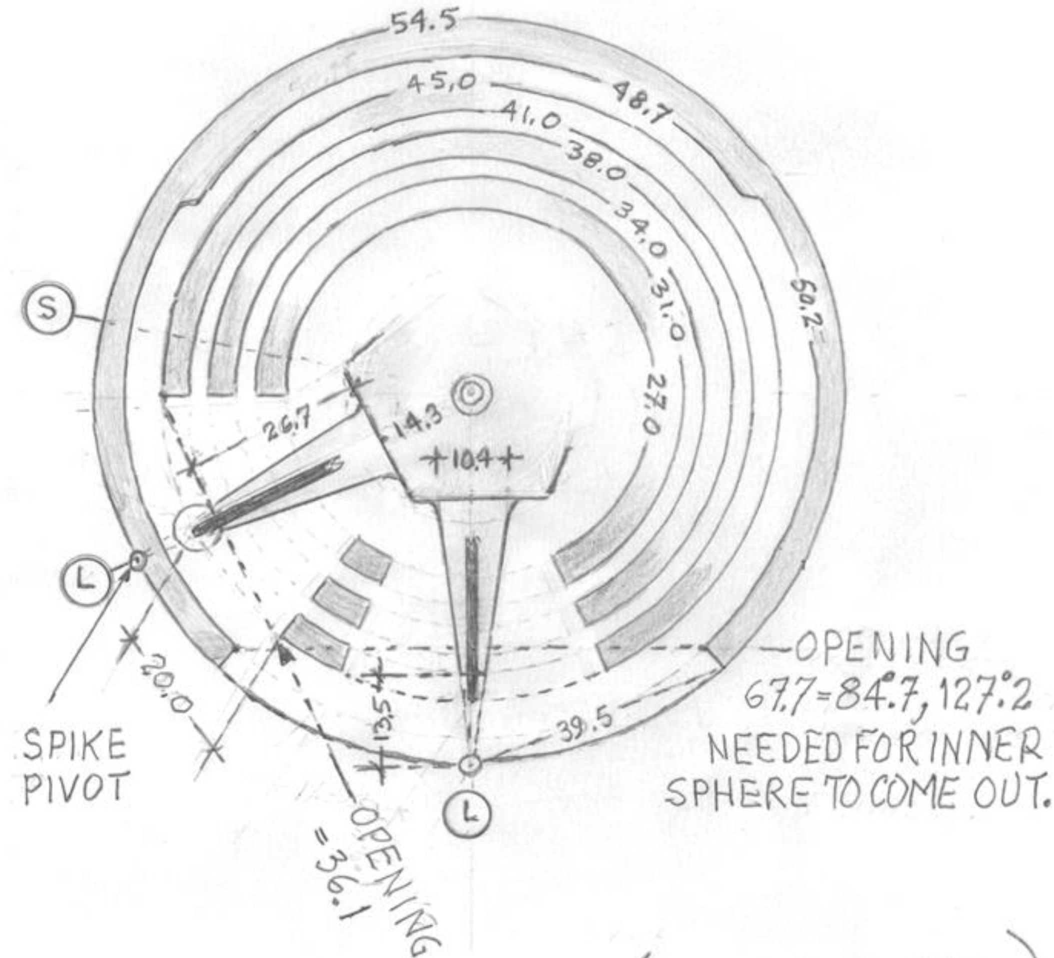
CHUCK RING



ITEM NO.3

— CYCLOPE —

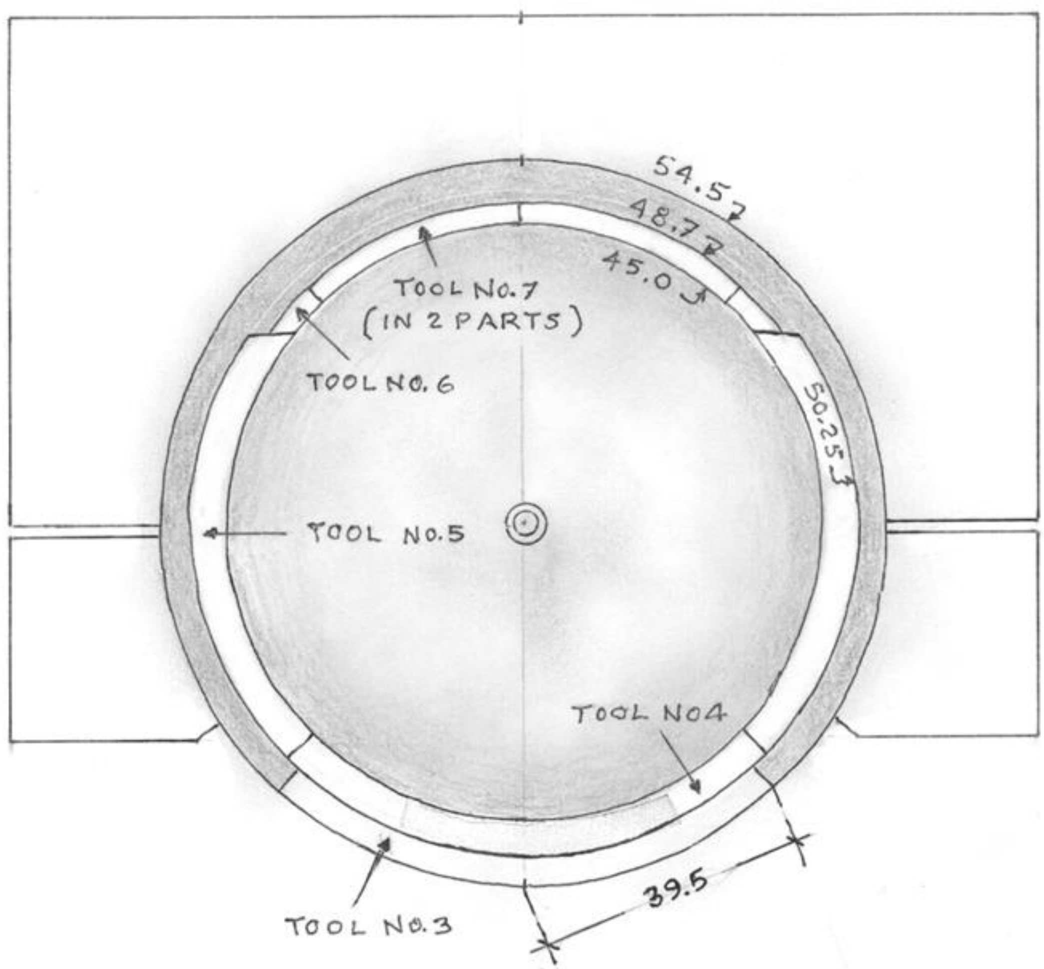
SPIKED DODECAHEDRON
IN 4 CONCENTRIC SPHERES
THE OUTER ONE WITH ONLY
ONE OPENING



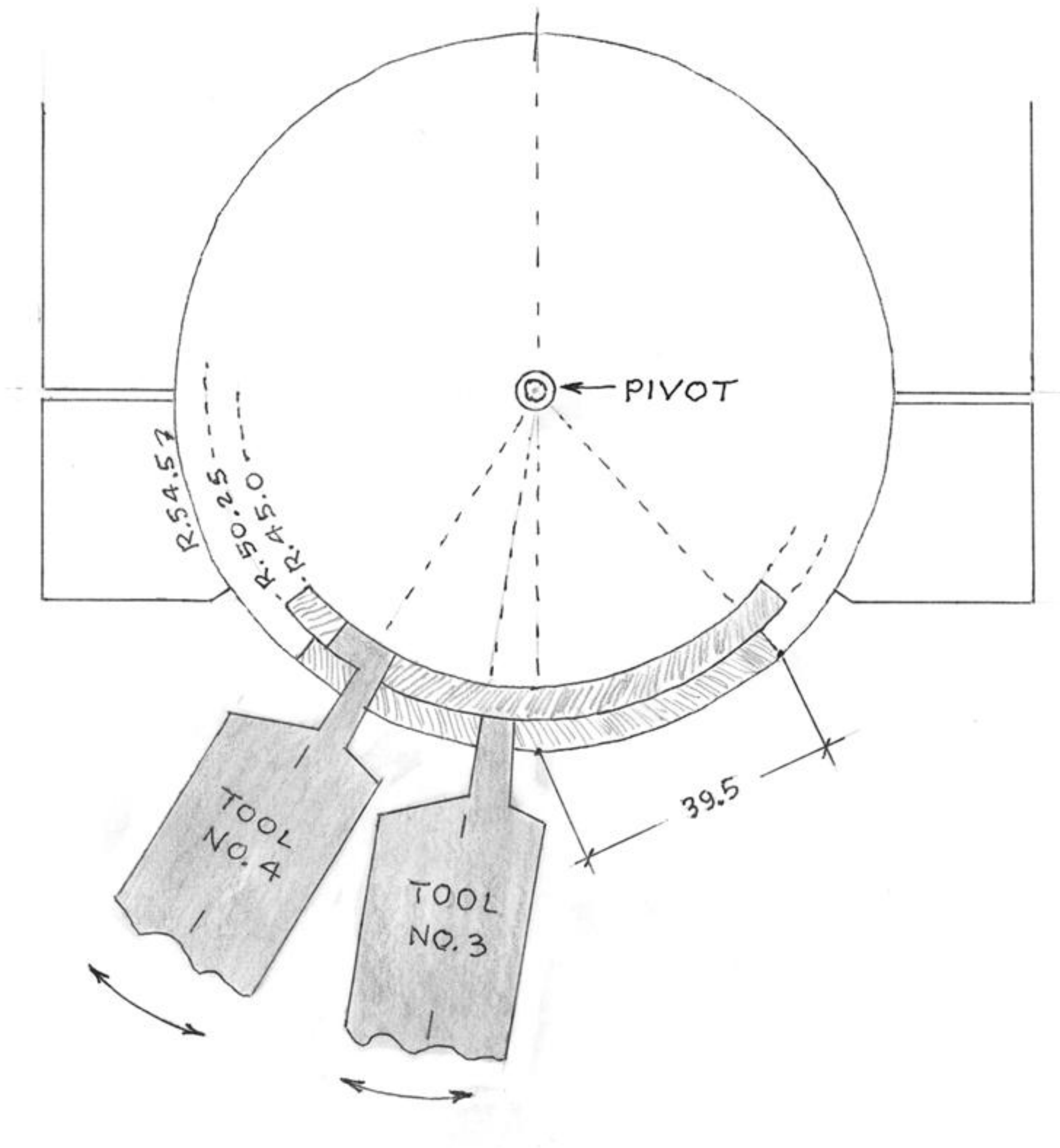
(DODECAHEDRON DIVISION)

ITEM NO. 5

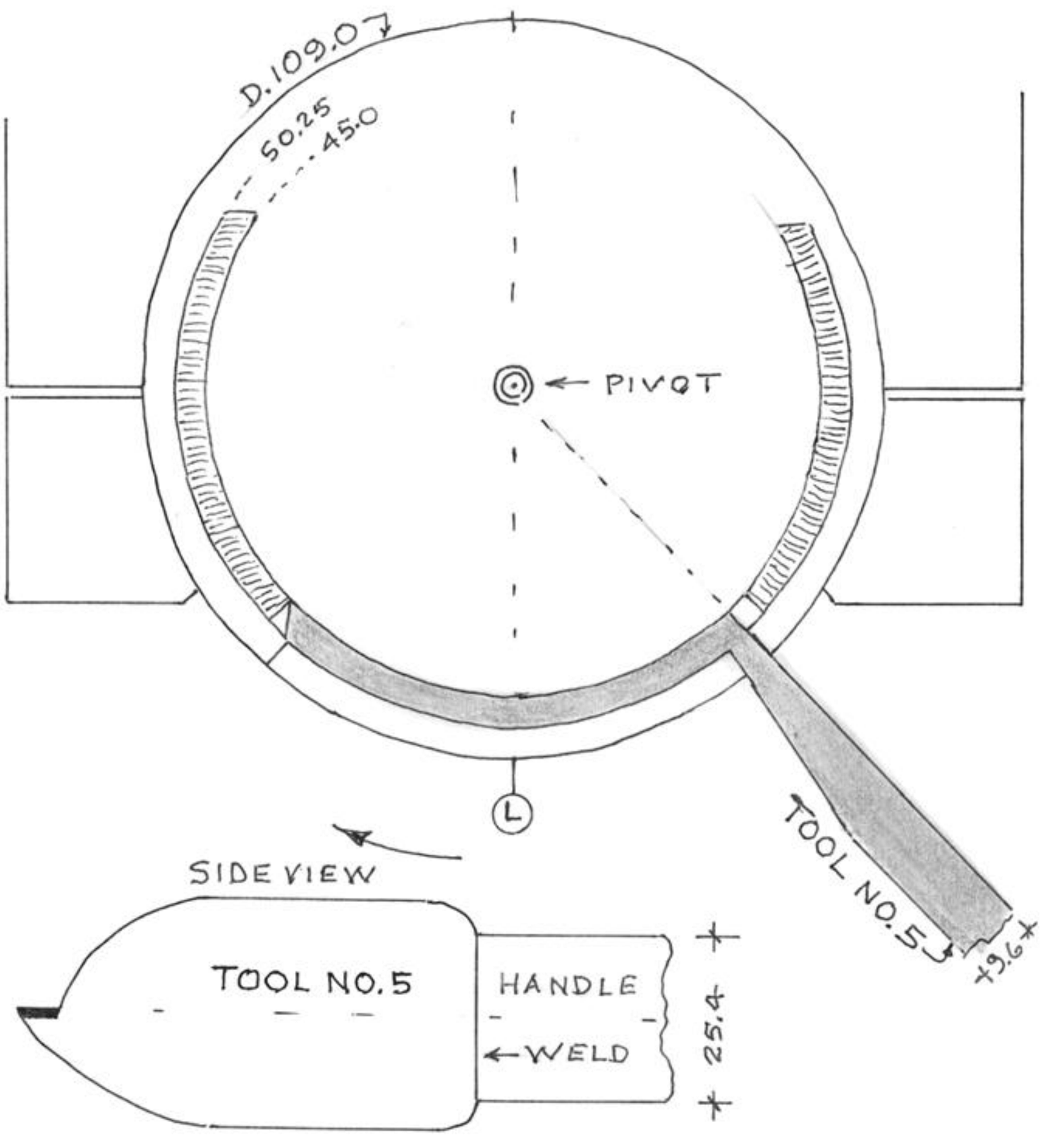
To free inside sphere Ø90.0 and what each tool cuts to do it

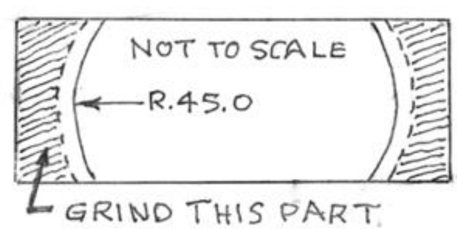


ITEM NO. 6



ITEM NO. 7

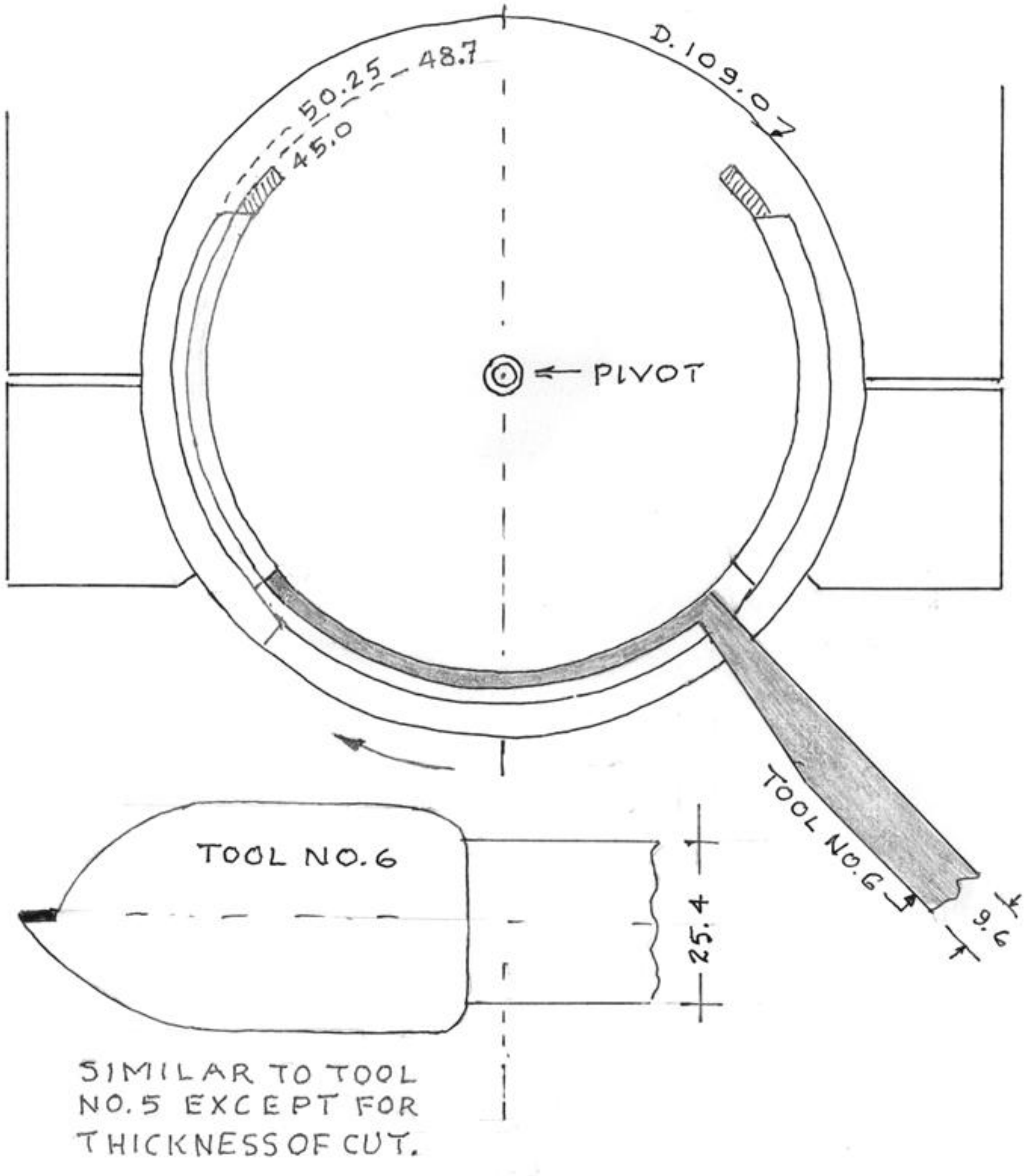




Tools N°5, 6 and 7 are made from the race ring of a self-alignment bearing. The radius is the same both ways thus perfect for a cup shape tool. (extremely hard stuff !)

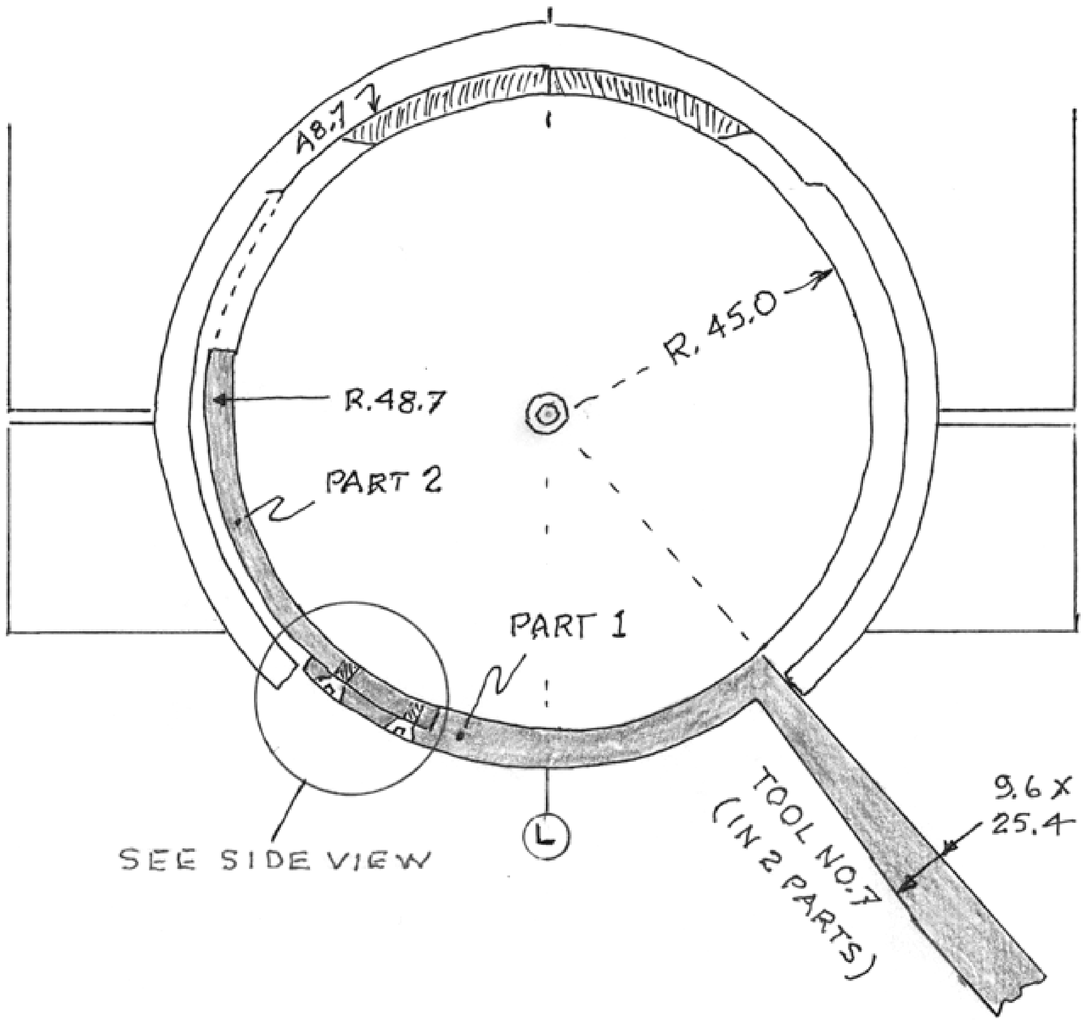
Note : The size of the race ring you have determines the size of the inner sphere

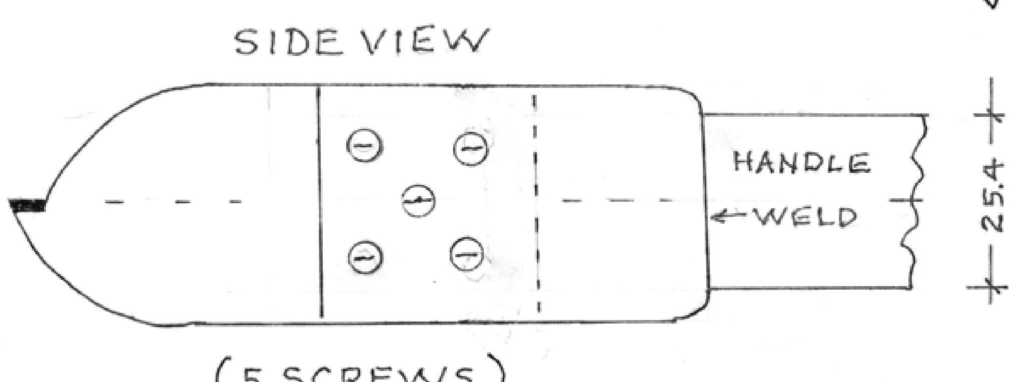
ITEM NO.8



D.109.07
50.25
48.7
45.0
PIVOT
TOOL NO.6
9.6
TOOL NO.6
25.4
SIMILAR TO TOOL NO.5 EXCEPT FOR THICKNESS OF CUT.

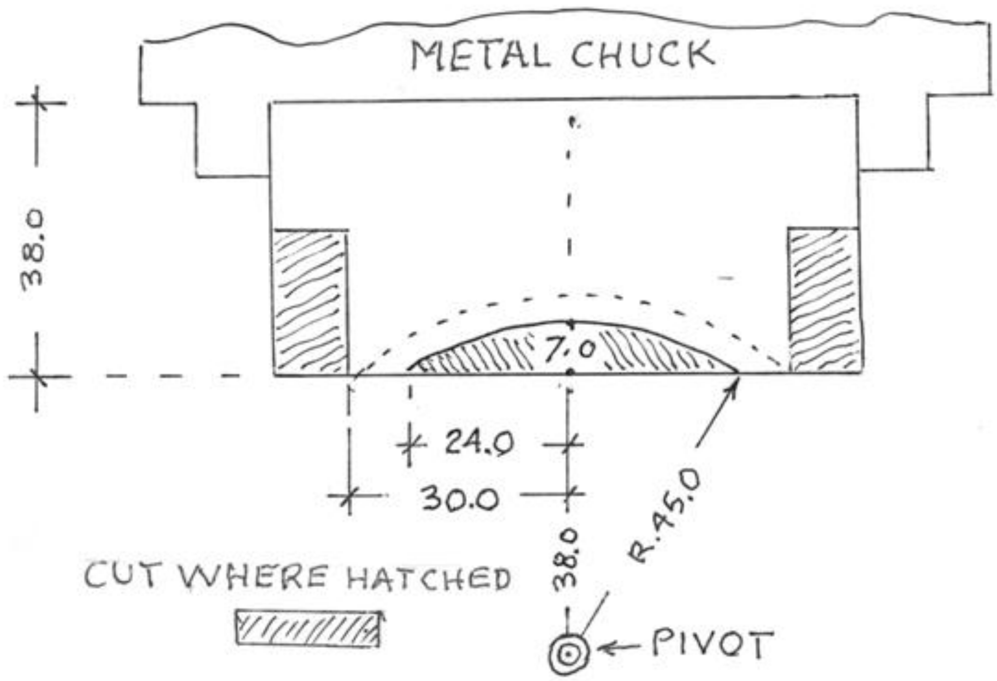
ITEM NO. 9

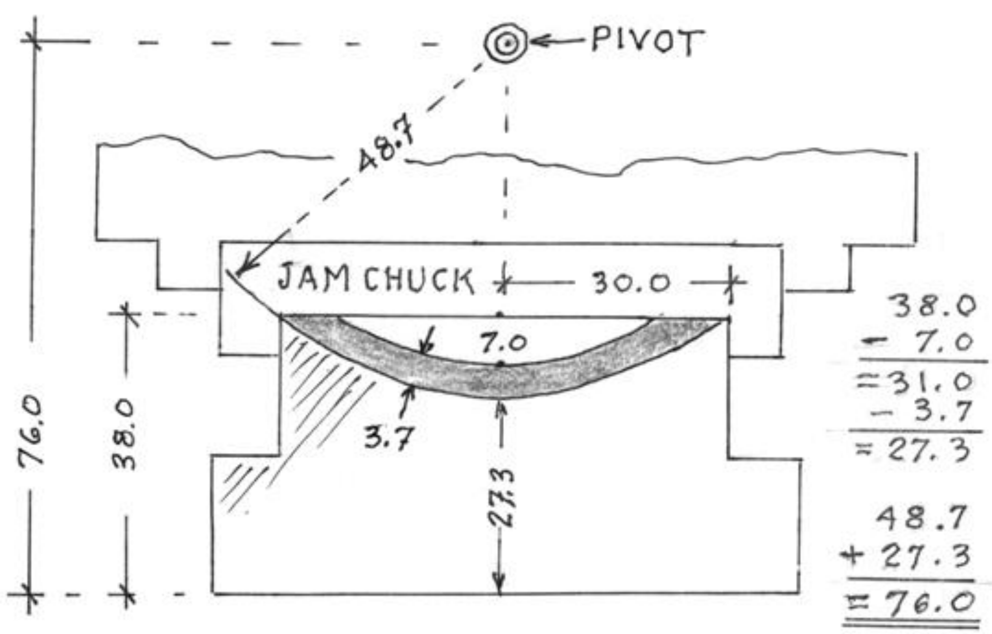

A8.7
R.45.0
R.48.7
PART 2
PART 1
SEE SIDE VIEW
L
TOOL NO.7 (IN 2 PARTS)
9.6 X 25.4


SIDE VIEW
HANDLE
WELD
25.4
(5 SCREWS)

ITEM NO. 11 ~ CUP ~

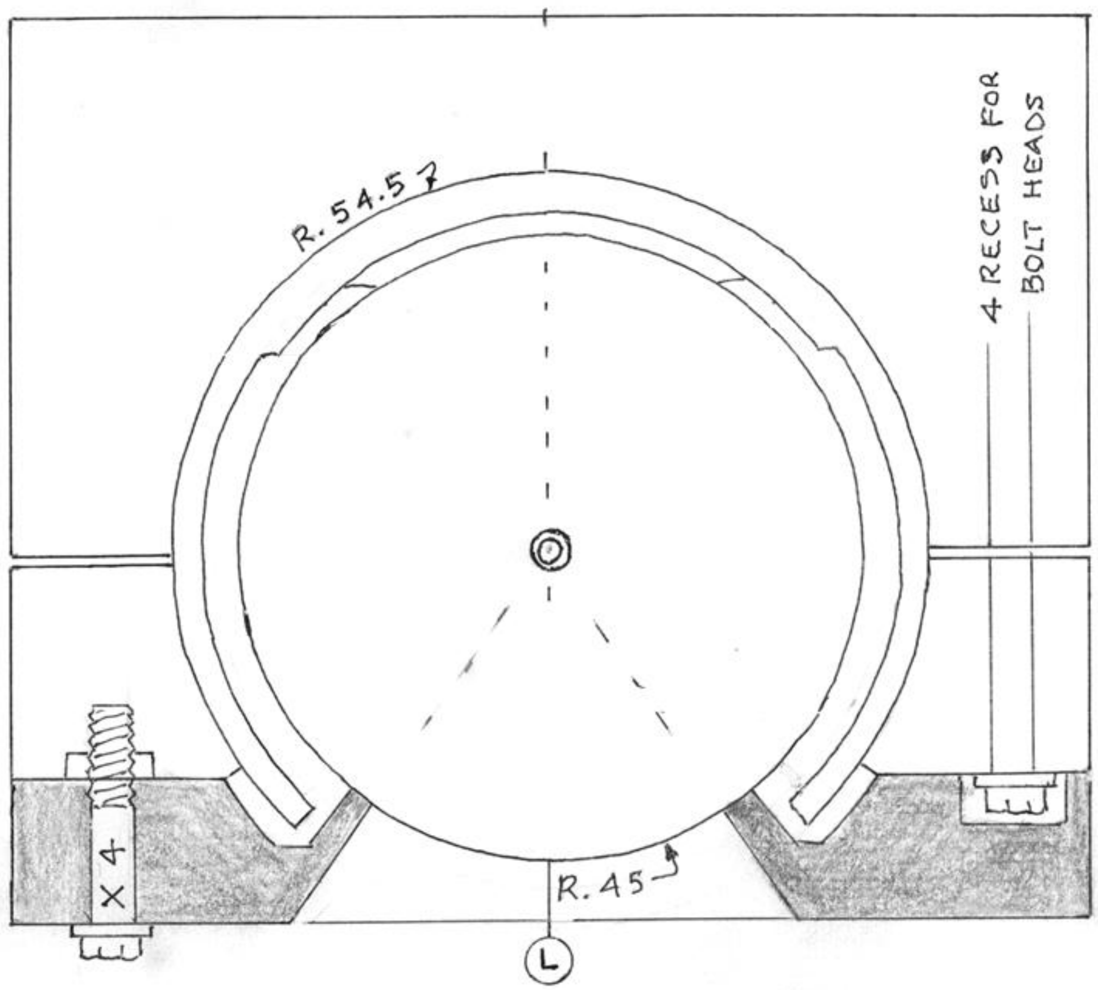
This cup is so inner ball has good bearing surface when pressed by the secondary ring. Best left in place to raise inner sphere in its original location





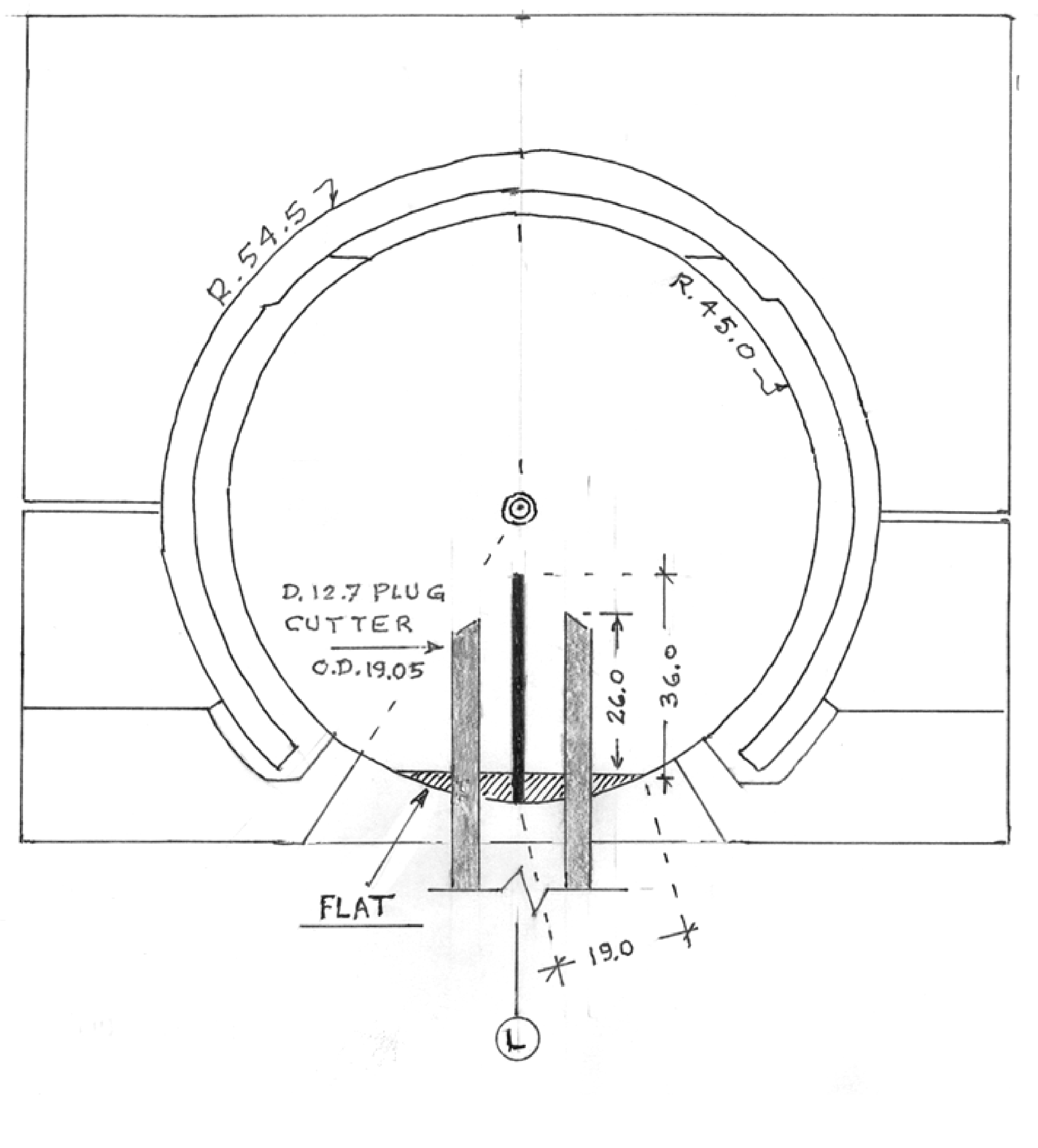
ITEM NO. 12

~ SECONDARY RING ~

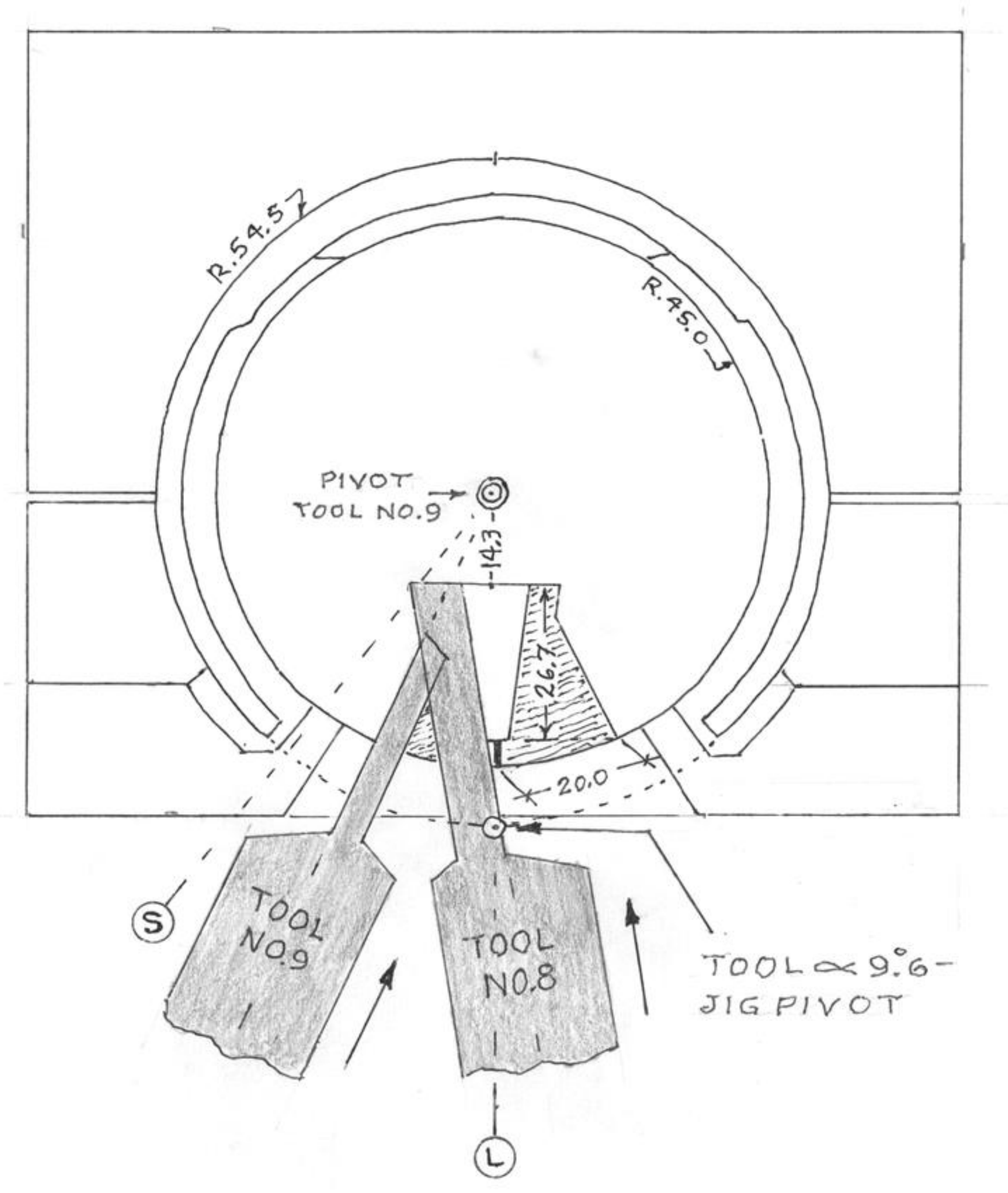


4 BOLTS IN BETWEEN
THE ONES OF THE
CHUCK RING.

ITEM NO. 14

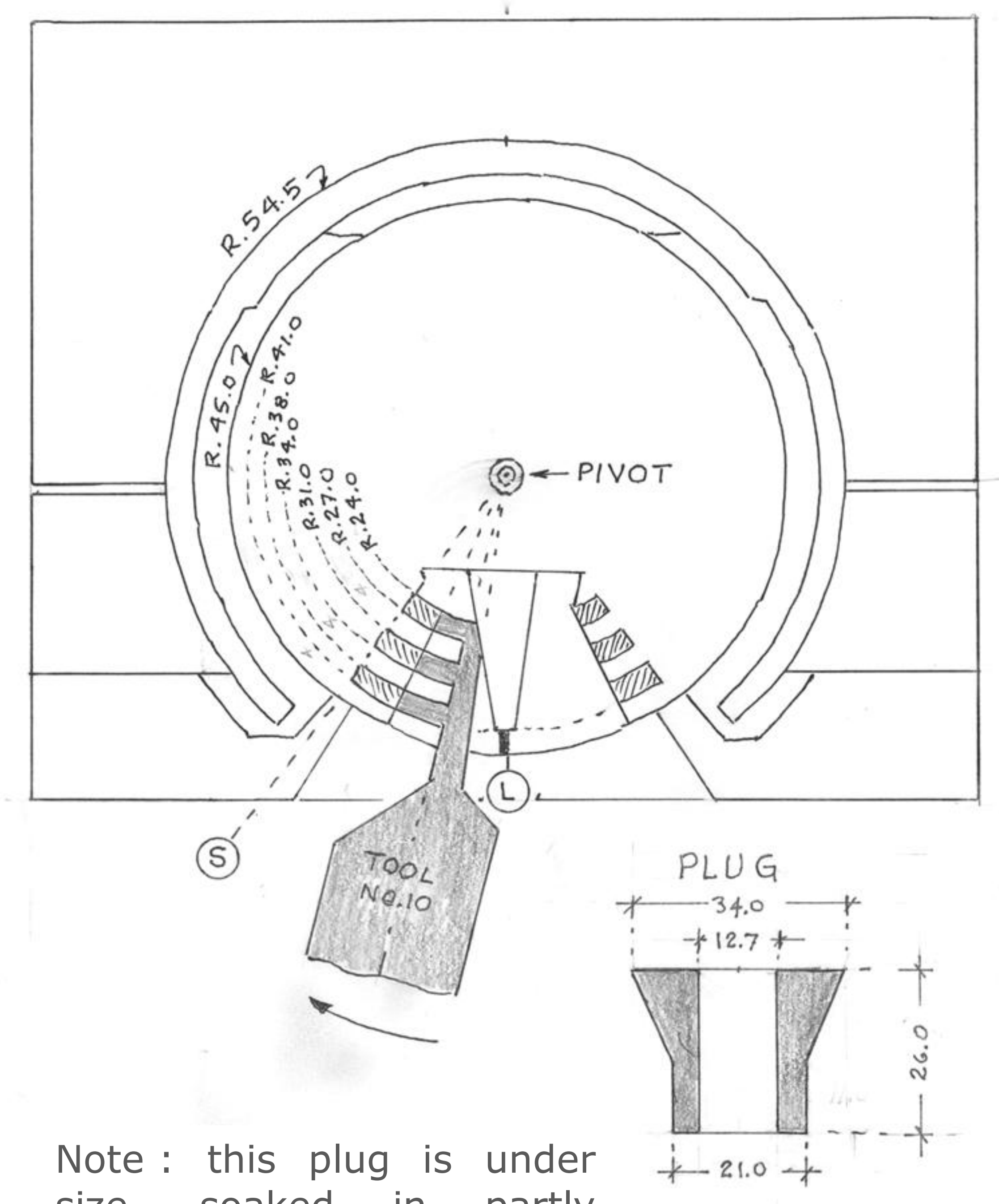


ITEM NO.15



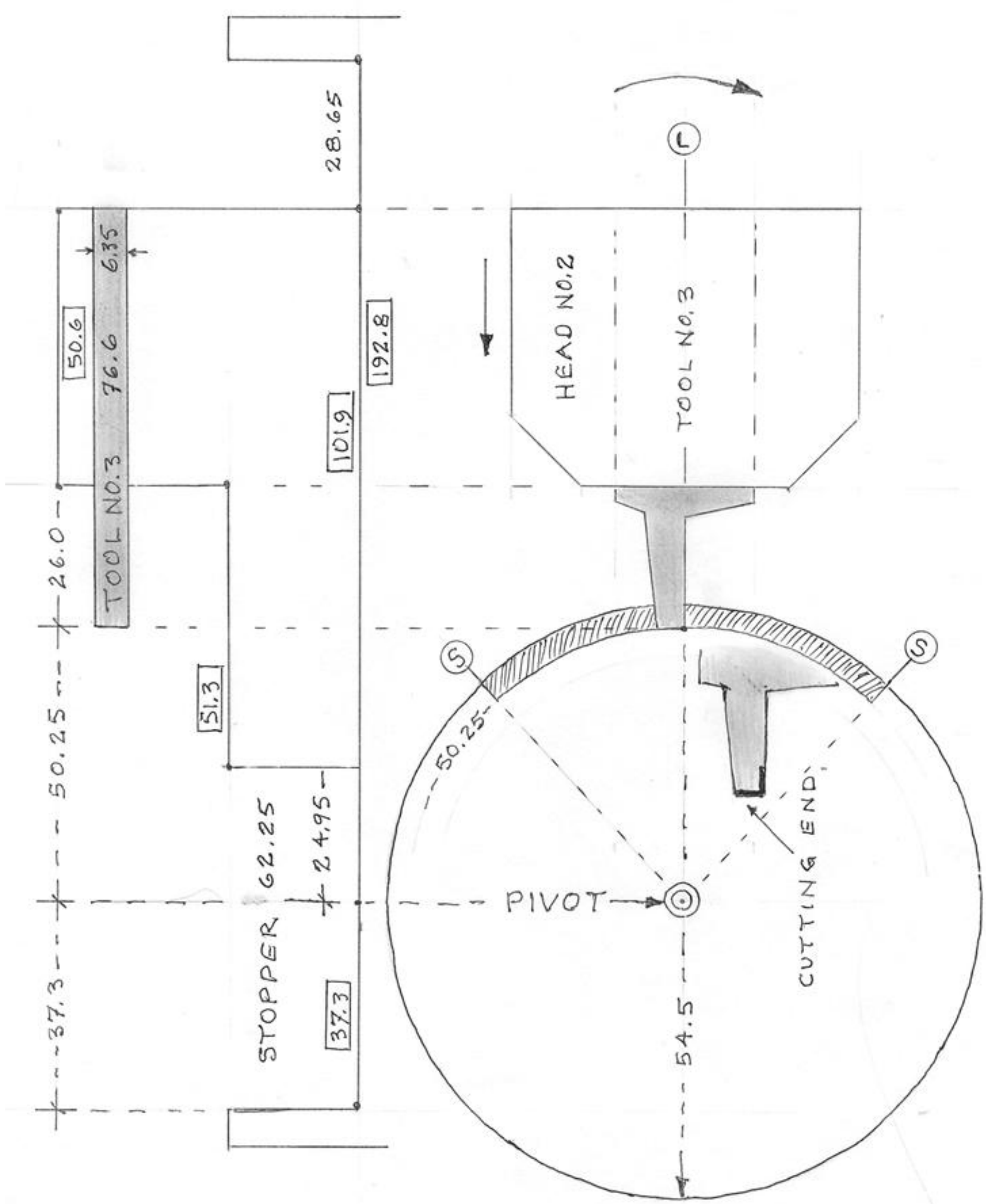
R.54.57
R.45.0
PIVOT
TOOL NO.9
14.3
26.7
20.0
TOOL NO.9
TOOL NO.8
TOOL ∝ 9.°6 -
JIG PIVOT
S
L

ITEM NO. 16

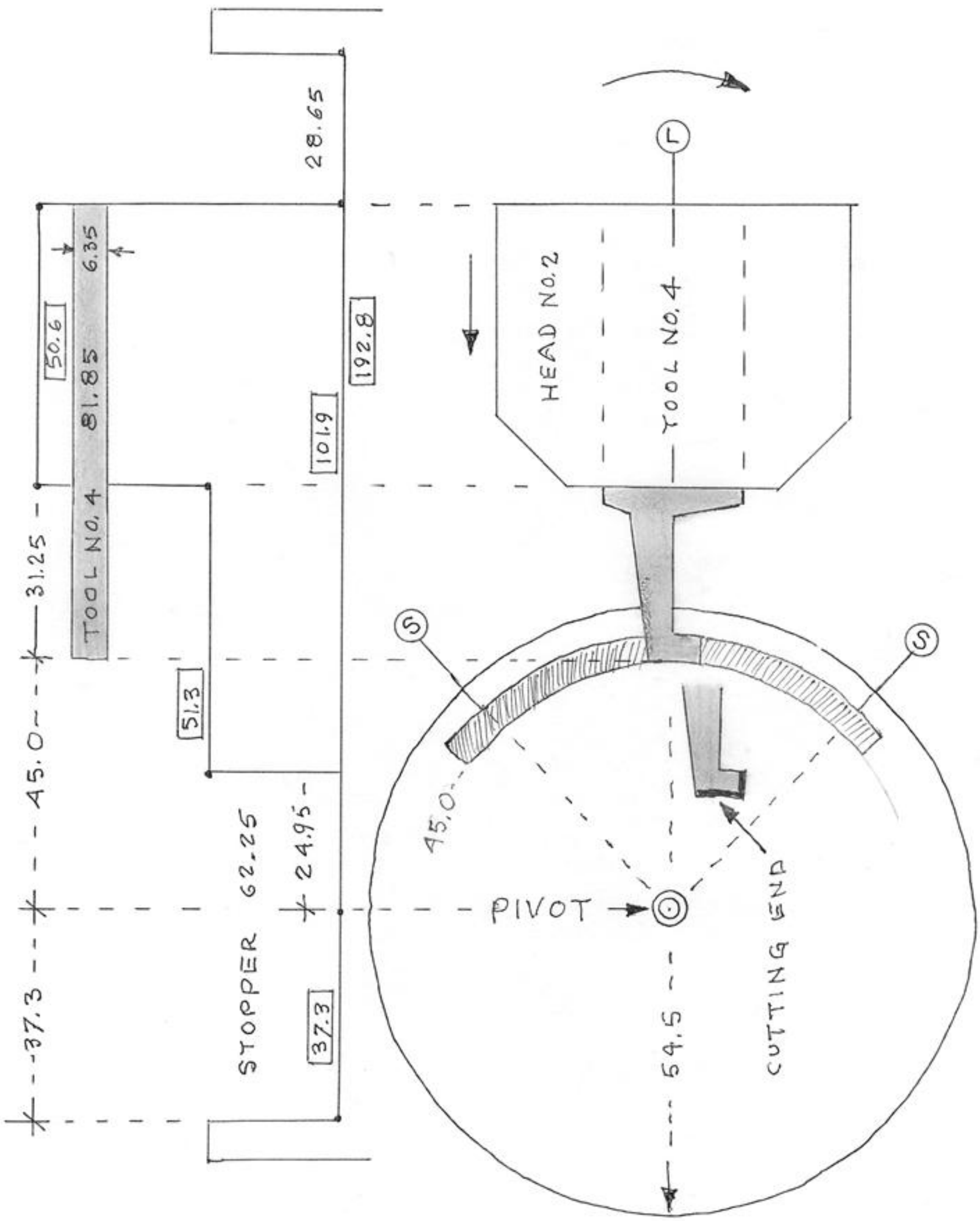


Note : this plug is under size, soaked in partly melted wax and quickly pressed in place so that the excess wax goes between the shells.

Item N° 20-1

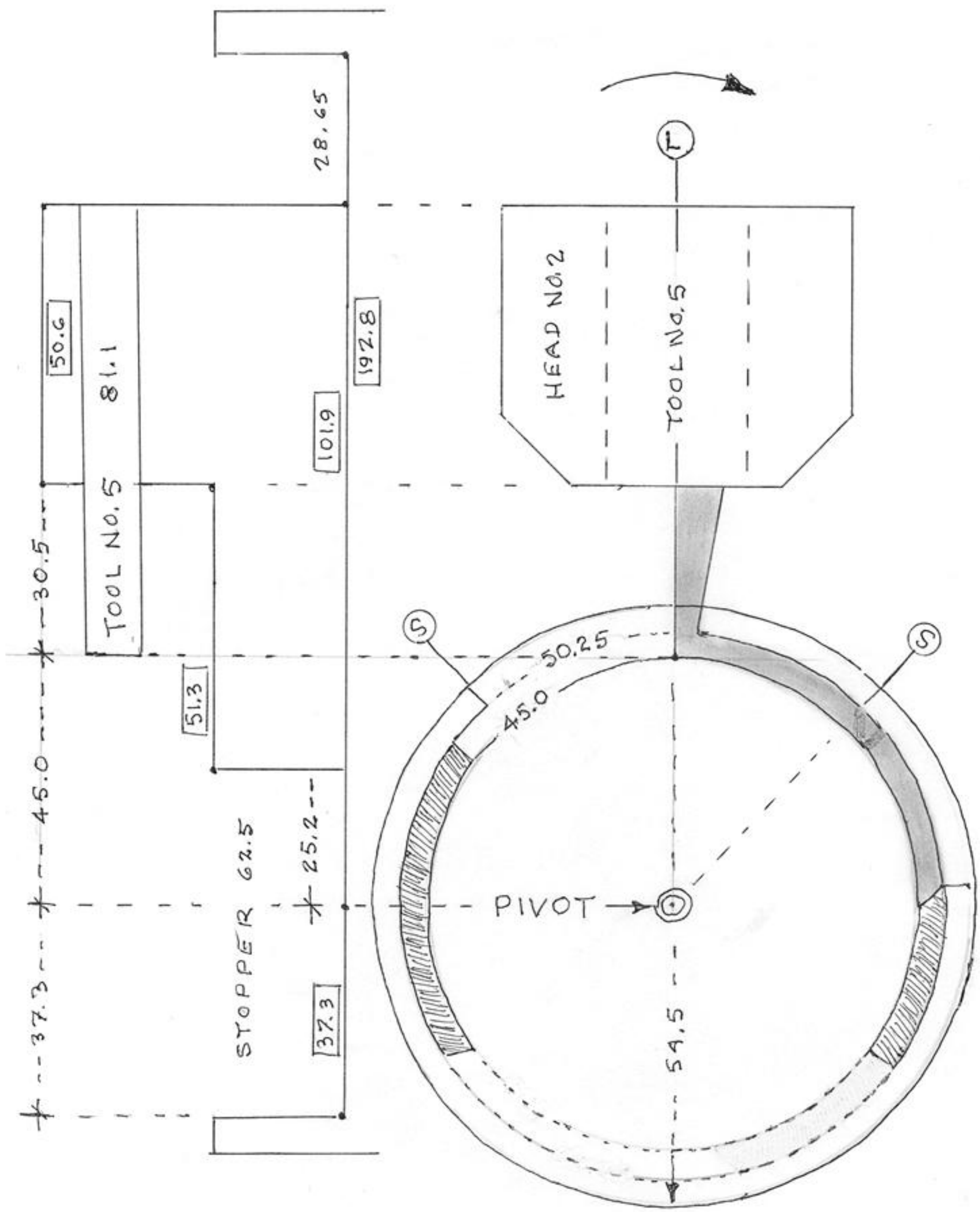

28.65
6.35
50.6
76.6
TOOL NO.3
192.8
101.9
HEAD NO.2
TOOL NO.3
26.0
50.25
51.3
50.25
62.25
24.95
STOPPER
PIVOT
CUTTING END
37.3
37.3
54.5

Item N° 20-2



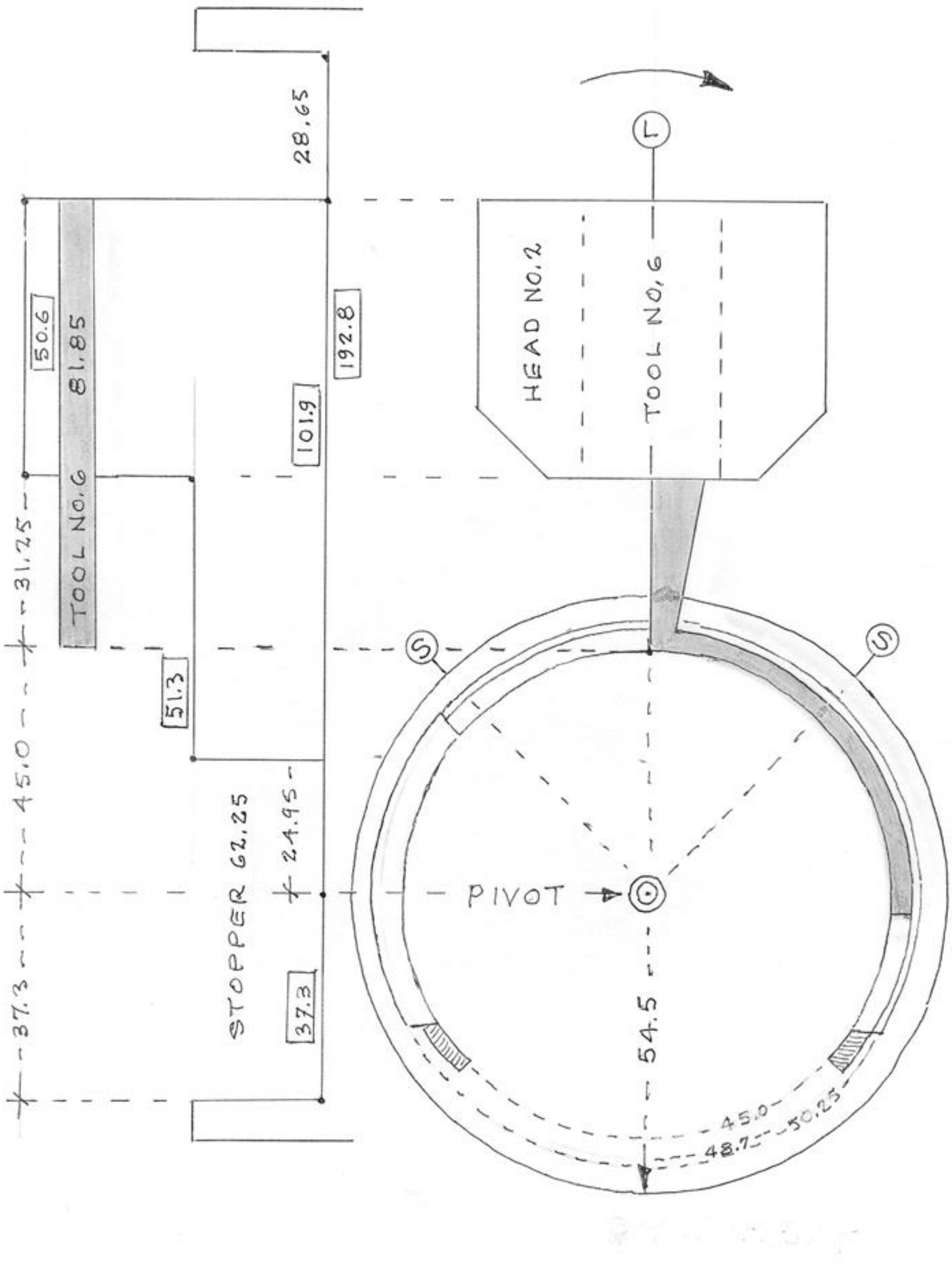
28.65
192.8
101.9
TOOL NO.4
6.35
50.6
81.85
31.25
45.0
51.3
37.3
STOPPER
62.25
24.95
37.3
HEAD NO.2
TOOL NO.4
L
S
S
45.0
PIVOT
CUTTING END
54.5

Item N° 20-3

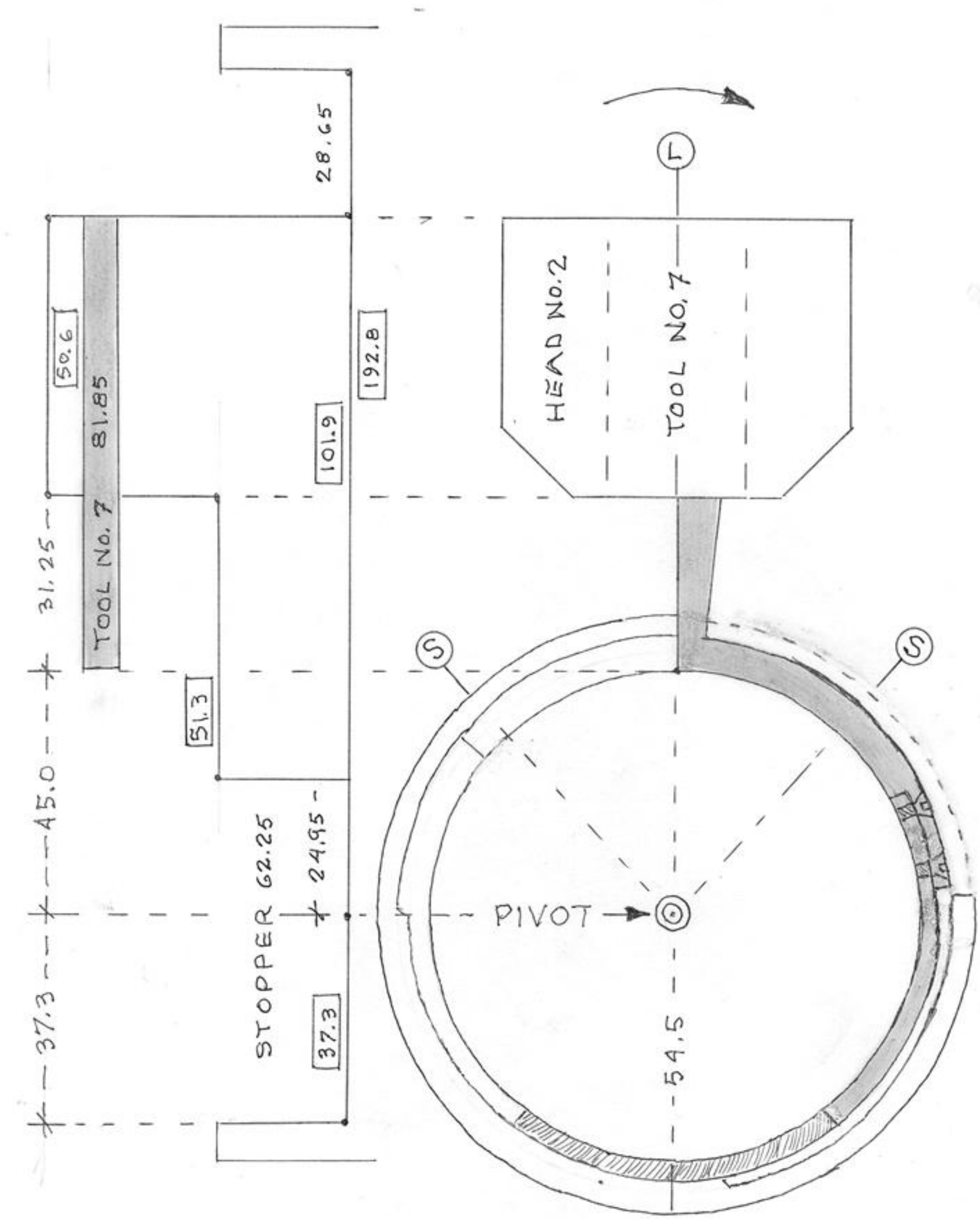


28.65
50.6
81.1
192.8
101.9
HEAD No.2
TOOL No.5
TOOL No.5
30.5
51.3
50.25
45.0
45.0
STOPPER 62.5
25.2
PIVOT
37.3
37.3
54.5

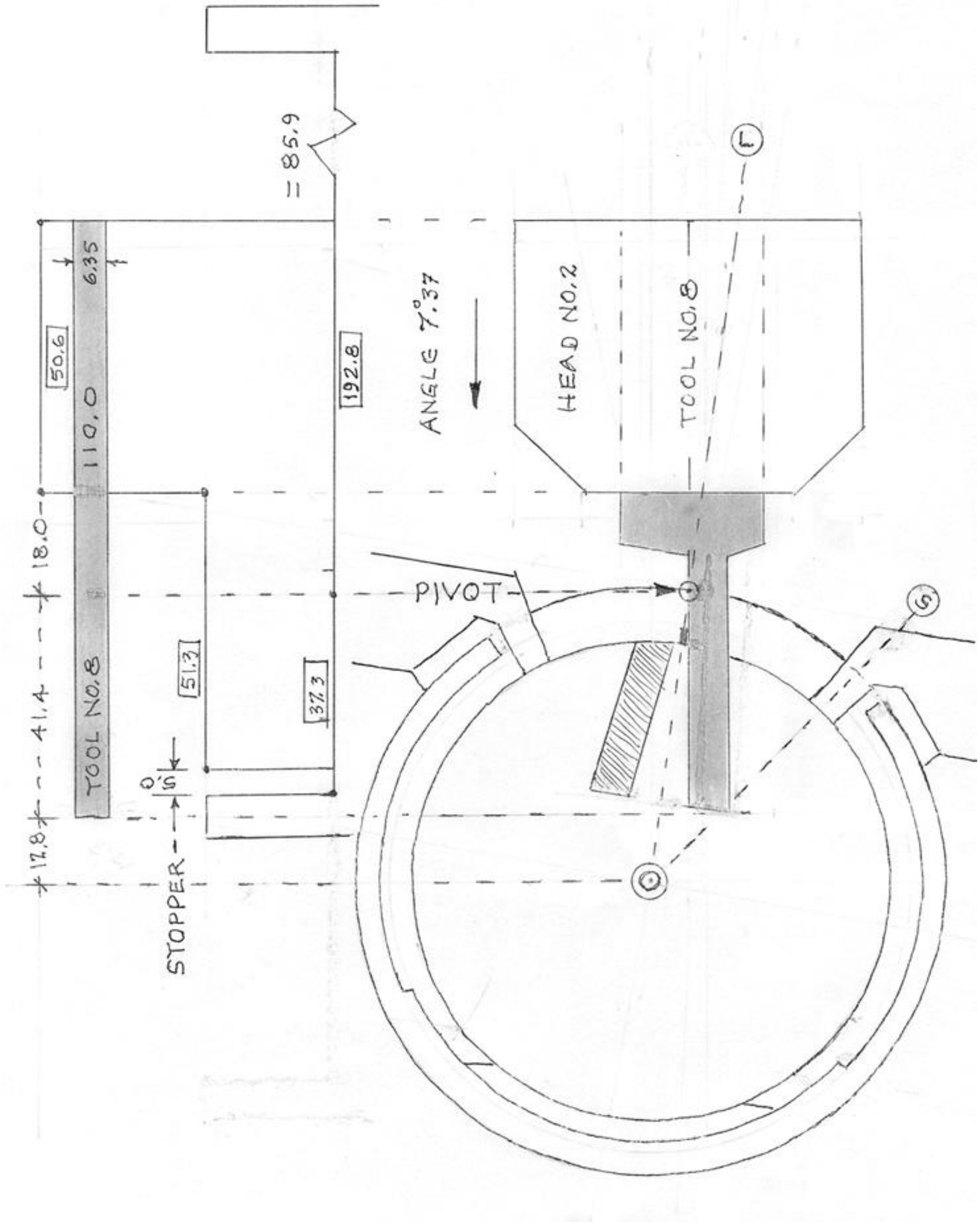
Item N° 20-4


28.65
50.6
81.85
TOOL NO.6
192.8
101.9
HEAD NO.2
TOOL NO.6
31.25
45.0
37.3
51.3
STOPPER 62.25
24.95
37.3
PIVOT
54.5
45.0
48.7
50.25

Item N° 20-5

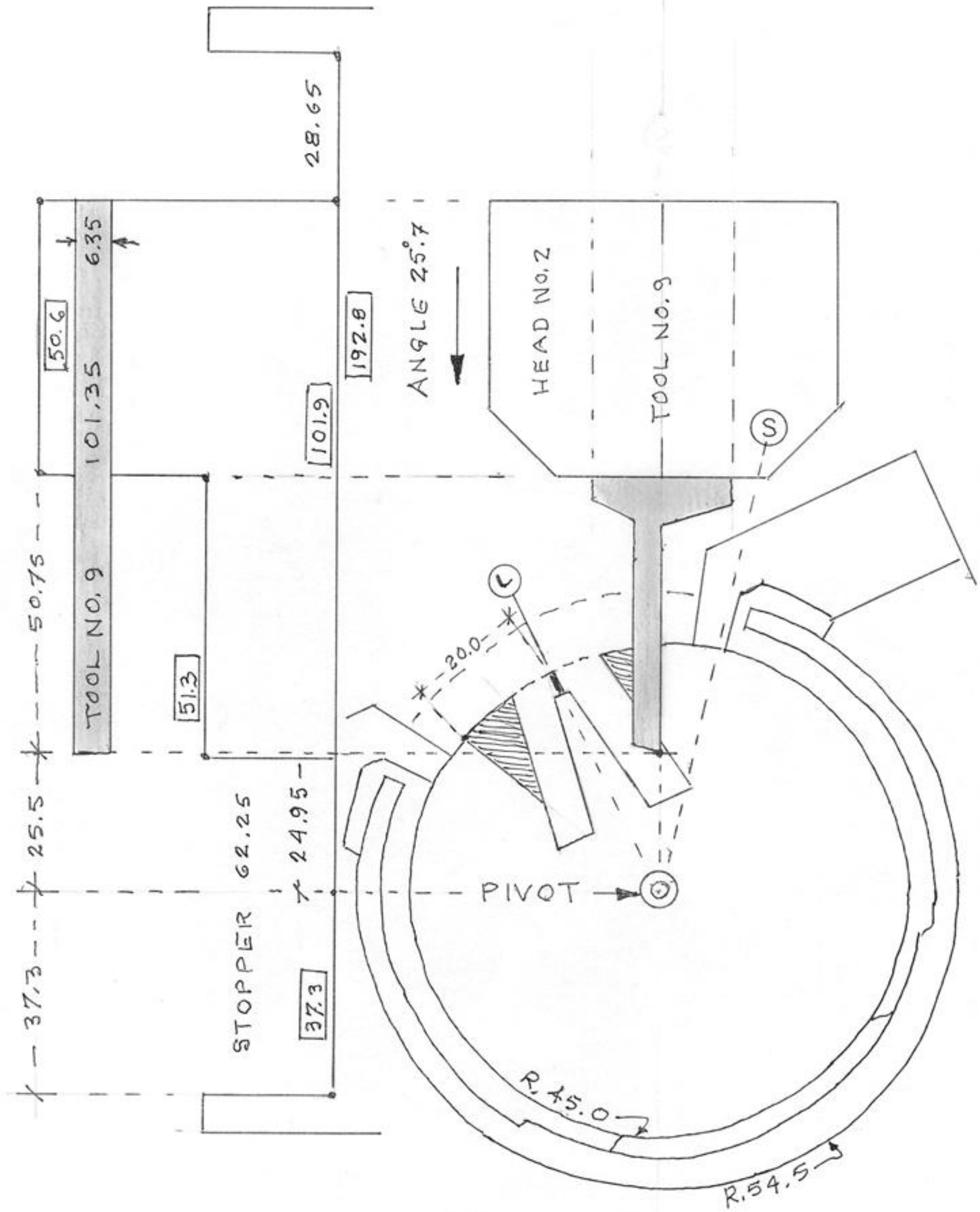

28.65
L
HEAD No.2
TOOL No.7
50.6
81.85
TOOL No. 7
192.8
101.9
31.25
51.3
45.0
STOPPER 62.25
24.95
37.3
37.3
PIVOT
54.5
S
S

Item N° 20-6



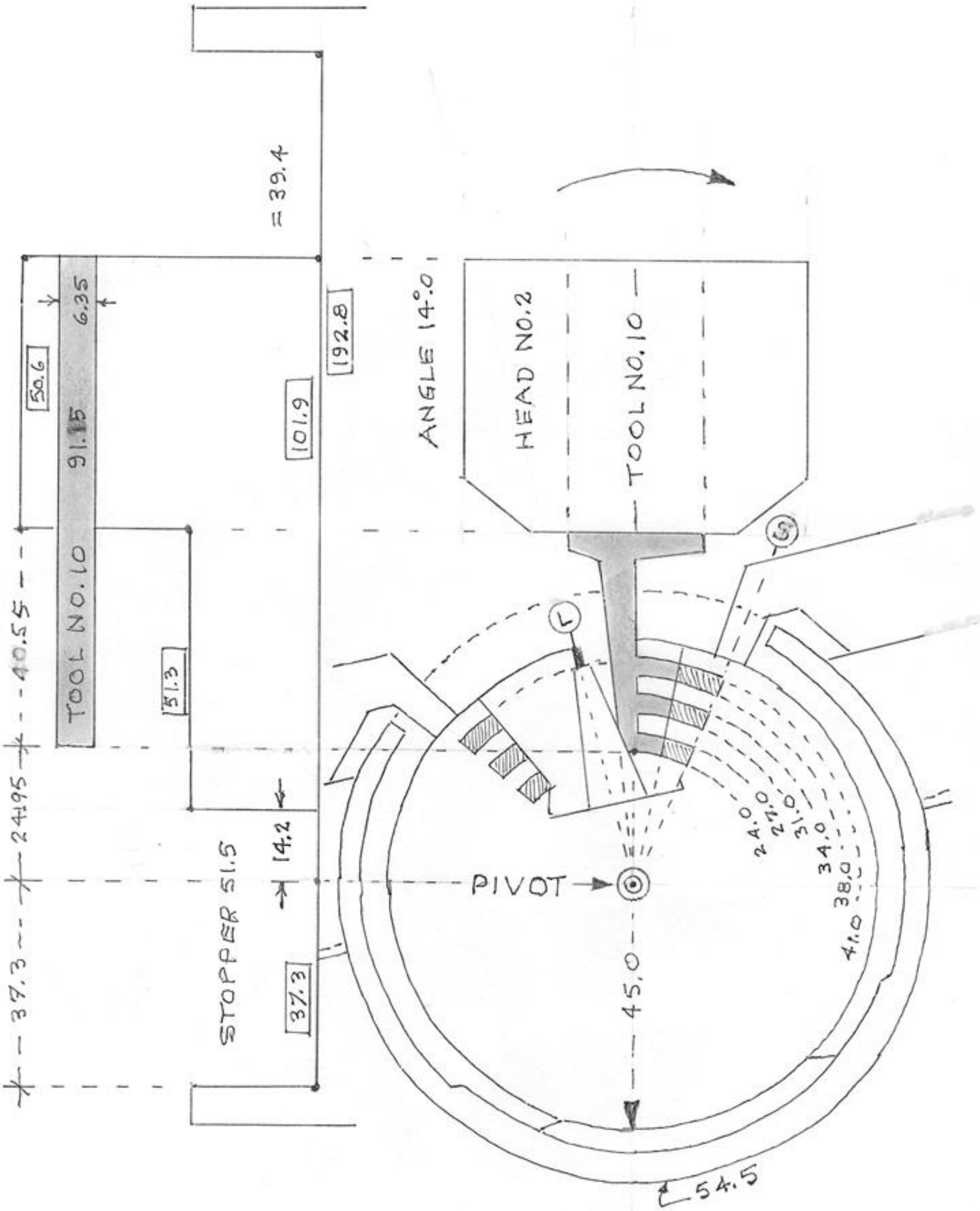
85,9
6,35
50,6
110,0
192,8
ANGLE 7°37
HEAD NO.2
TOOL NO.8
18,0
PIVOT
41,4
TOOL NO.8
51,3
37,3
0,5
17,8
STOPPER

Item N° 20-7



28.65
6.35
50.6
101.35
192.8
101.9
ANGLE 25°.7
HEAD No.2
TOOL No.9
S
L
20.0
50.75
TOOL No.9
51.3
25.5
62.25
24.95
PIVOT
STOPPER
37.3
37.3
R.45.0
R.54.5

Item N° 20-8

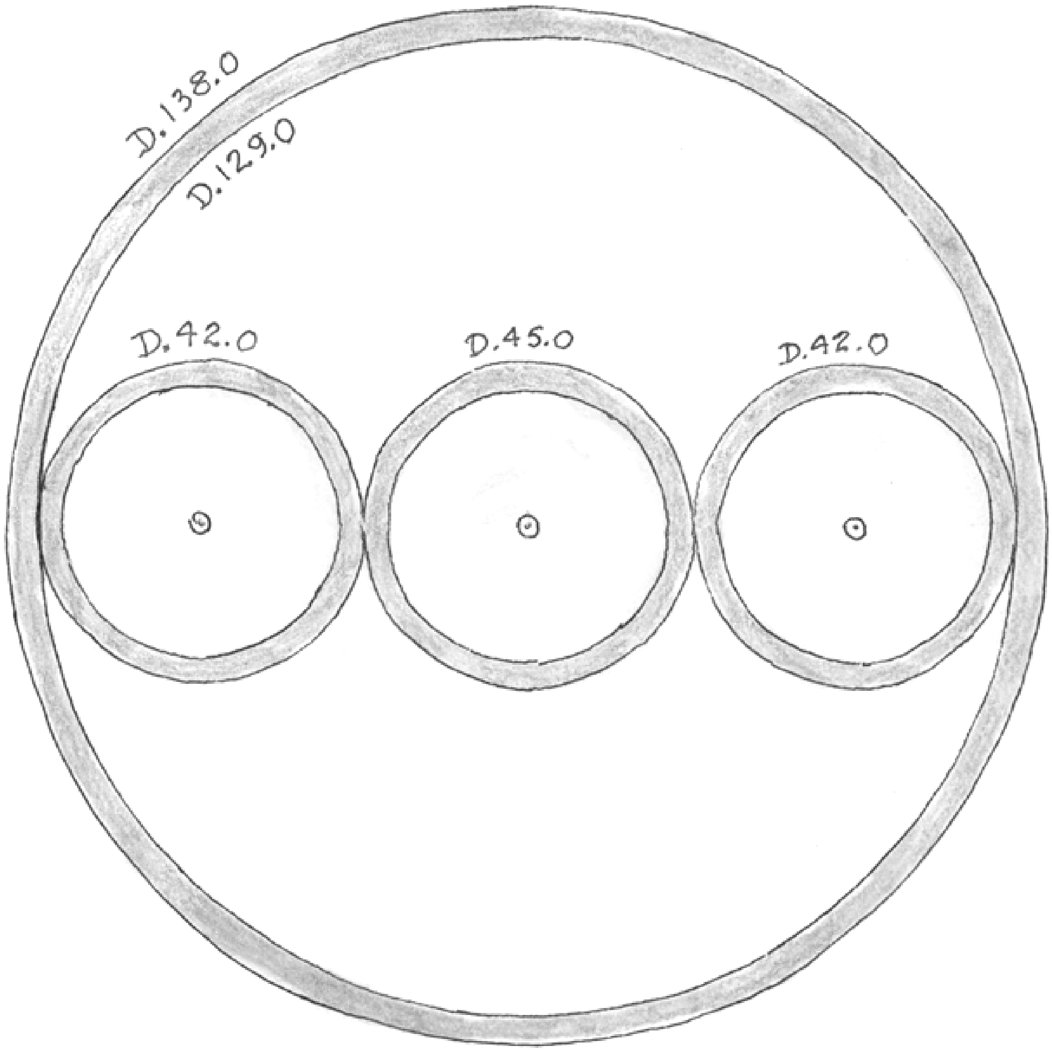

= 39.4
ANGLE 14°0
HEAD NO.2
TOOL NO.10
192.8
101.9
50.6
91.15
6.35
TOOL NO.10
40.55
31.3
14.2
STOPPER 51.5
37.3
37.3
PIVOT
45.0
54.5
24.0
27.0
31.0
34.0
38.0
41.0
L
G

Tour de Force

F - “Baker’s Dozen”

Claude LETHIECQ

SPECIAL FEATURE OF THIS PIECE
13 SPHERES INSIDE
(NO SPACE BETWEEN FOR TOOLS)



$$\begin{array}{rr} & 42.0 \\ + & 45.0 \\ + & 42.0 \\ \hline = & 129.0 \end{array}$$

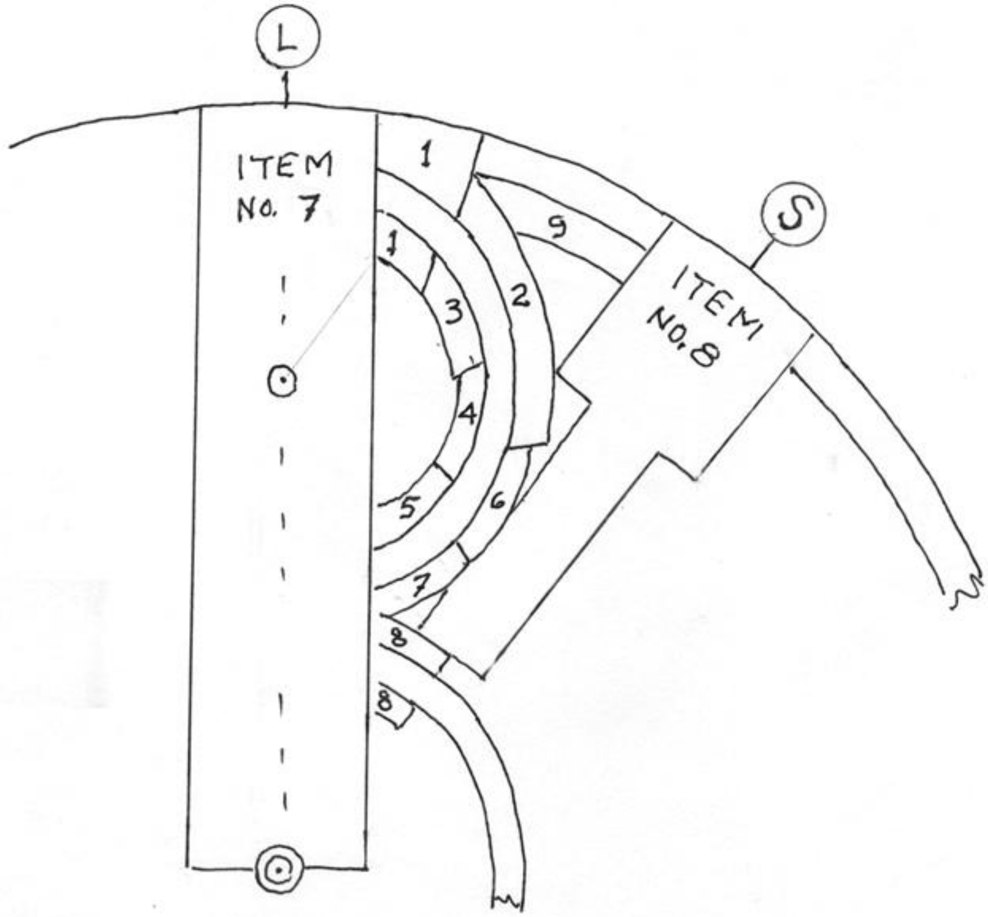
SAME AS INSIDE
OF MAIN SPHERE
D.129.0

~ *Sequence of operations* ~

Item

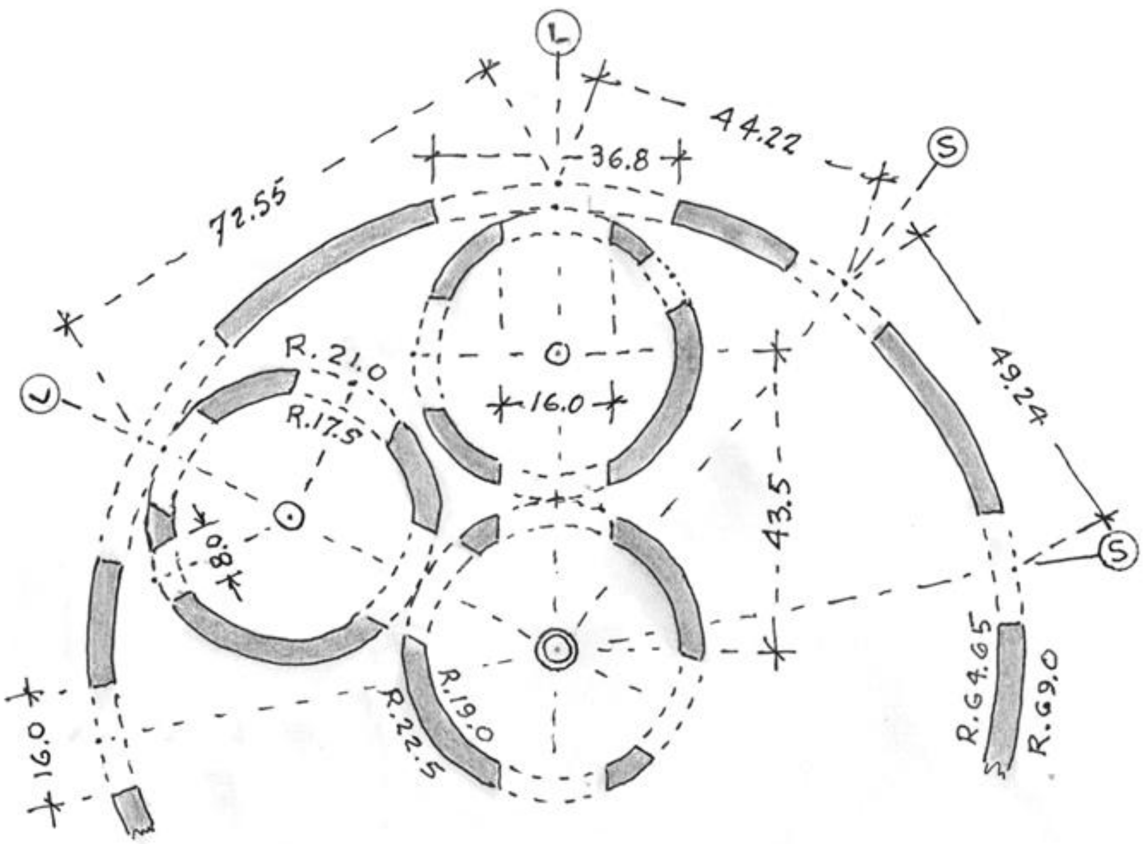
1. Use same chuck as the piece “Implosion”
2. Draw cross-section
3. Turn sphere Ø138.0
4. Make all 9 tools
5. On Ø138.0 sphere mark 12 Ⓛ points and 20 Ⓢ points (dodecahedron divisions)
6. Line up an Ⓢ point, drill Ø16.0 hole 18 deep, then 26.0 additional dept at D8.0 for a total of 44.0
7. Repeat item N°6 for all 20 Ⓢ points
8. Line up an Ⓛ point, mark circle Ø36.8
9. On same Ⓛ point drill Ø16.0 69.0 deep
10. Set jig pivot at 43.5 from ⦿
11. Use tool N°1
12. Use tool N°2
13. With hand tool remove hatched section
14. Use tool N°3
15. With hand tool remove hatched section
16. Use tools N° 4, 5, 6 and 7
17. Set jig pivot at ⦿ and use tool N°8
18. Use tool N°9
19. Jam the loose sphere at the 4 x marks. Each tool position in sphere jig : 19-1 to 19-9
20. On all Ⓛ R.21.0 spheres mark 4 Ⓛ points (since 2 are already cut) and 8 Ⓢ points
21. Repeat items N°8 to 19 until all 12 Ⓛ openings are done
22. Remove whatever you used to jam the 12 R.21.0 spheres
23. Set secondary ring and push rod + block
24. With push rod and block, push Ⓛ spheres tight against secondary ring and in succession drill Ø16.0 for 4 Ⓛ points and 8.0 for 8 Ⓢ points
25. Repeat item 24 for all 12 Ⓛ spheres
26. Remove all loose wood inside sphere.

~ WHAT EACH TOOL CUTS ~

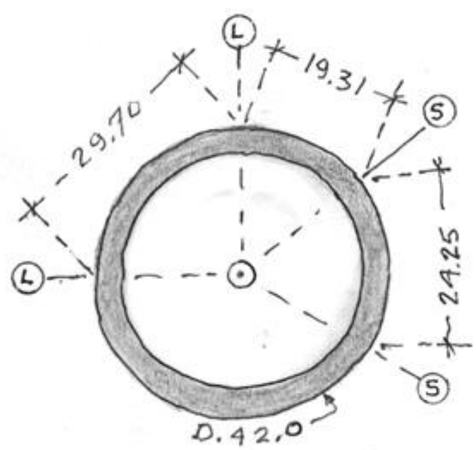


— NOT TO SCALE —
(SCHEMATIC)

ITEM NO.2 CROSS-SECTION



For Ø 45.0 central sphere
No marking necessary
Openings by item N°4
Inside cut by tool N°8

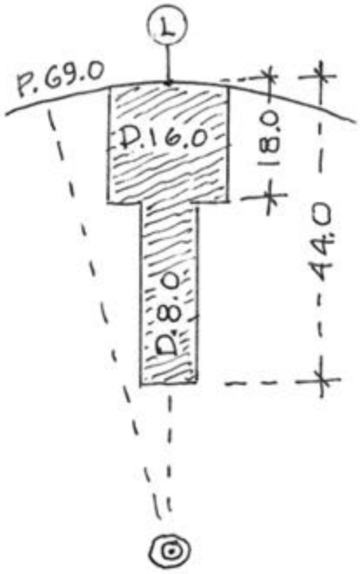


For Ø 138.0 sphere
12 divisions
L-L = 138 x 0.5257 = 72.55
L-S = 138 x O.3204 = 44.22
S-S = 138 x 0.3568 = 49.24

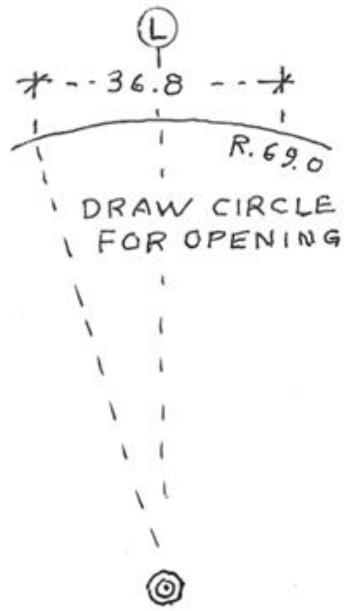
For Ø 42.0 sphere
6 divisions 6 Ⓛ and 8 Ⓢ
L-L = 42 x 0.7071 = 29.70
L-S = 42 x O.4597 = 19.31
S-S = 42 x 0.5774 = 24.25

ITEM NOS. 6,8,9,11 AND 12

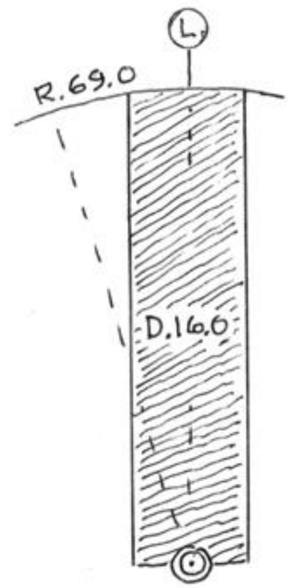
ITEM NO.6



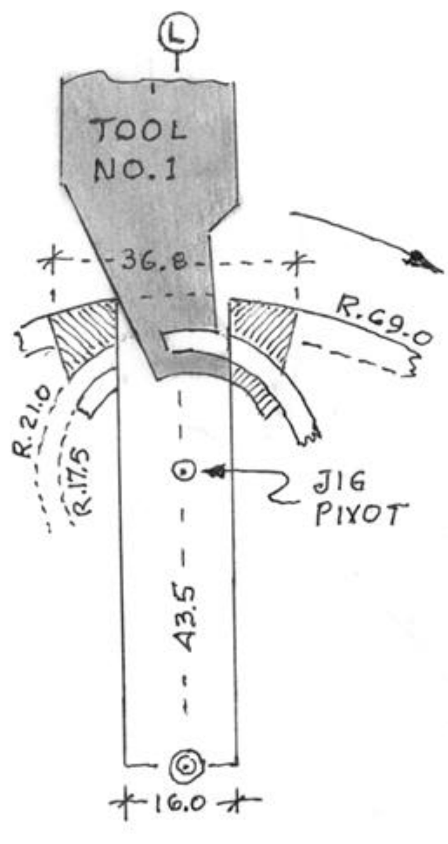
ITEM NO.8



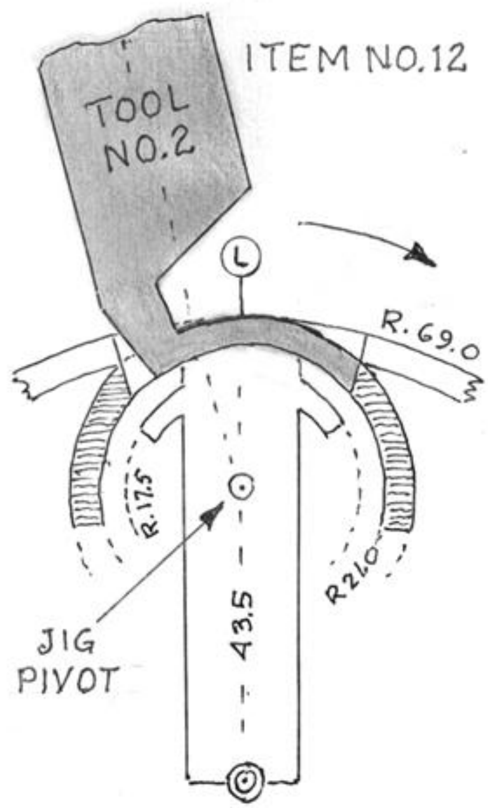
ITEM NO.9



ITEM NO.11

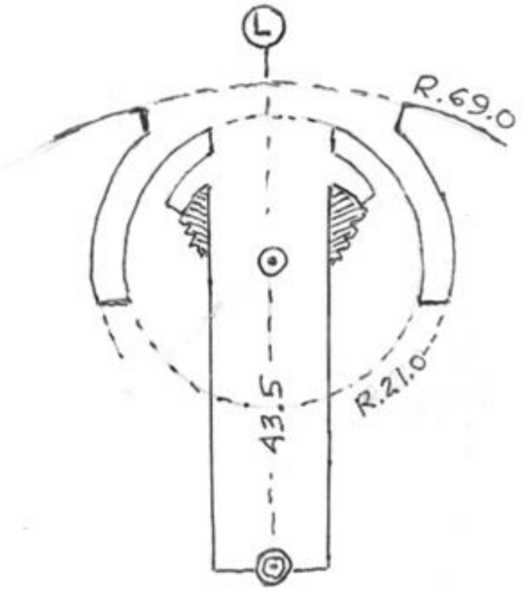


ITEM NO.12

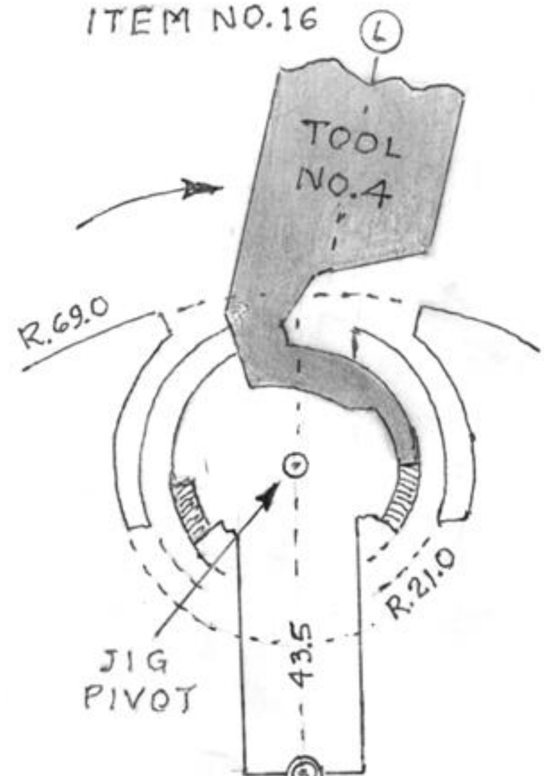


ITEM NOS. 13, 14, 15 AND 15

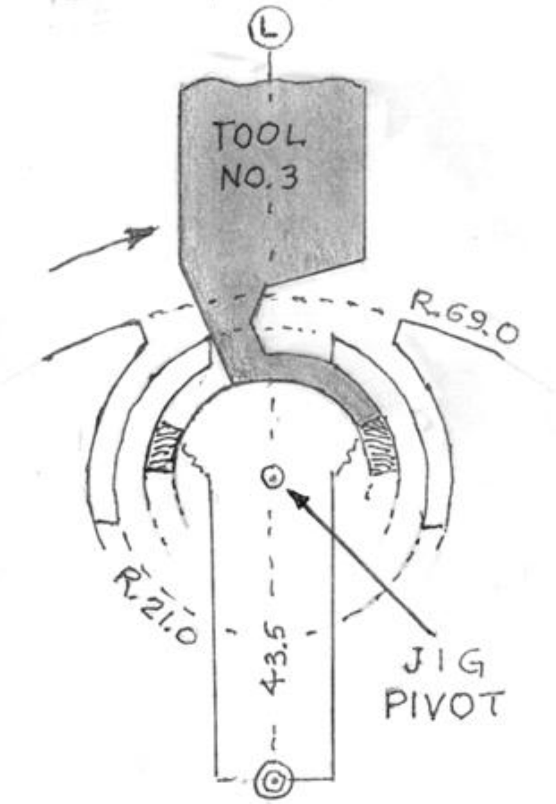
ITEM NO. 13



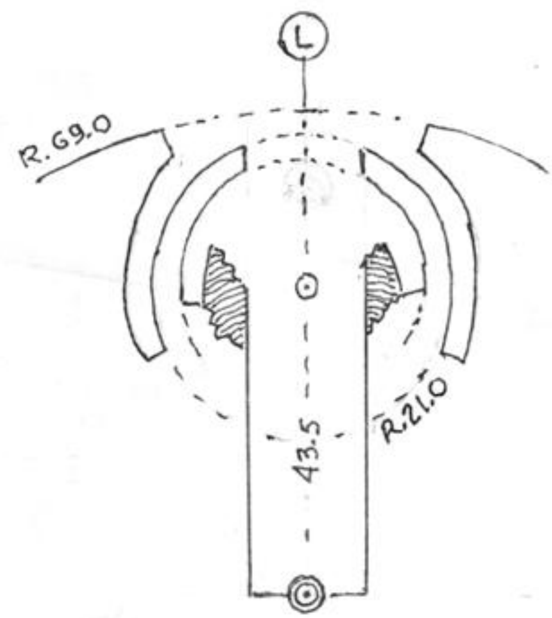
ITEM NO. 16

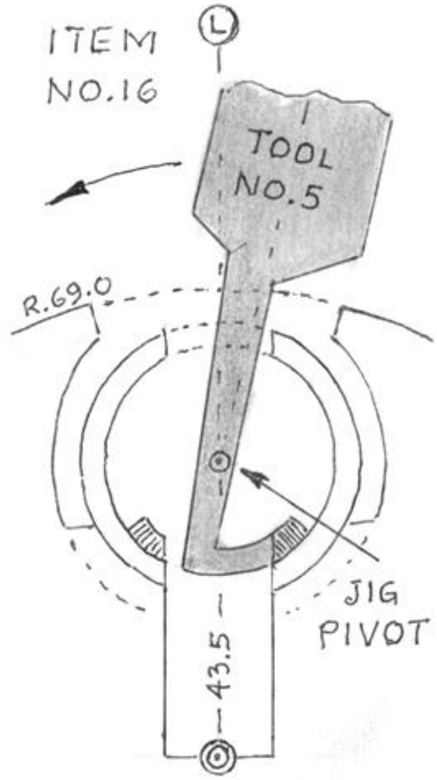


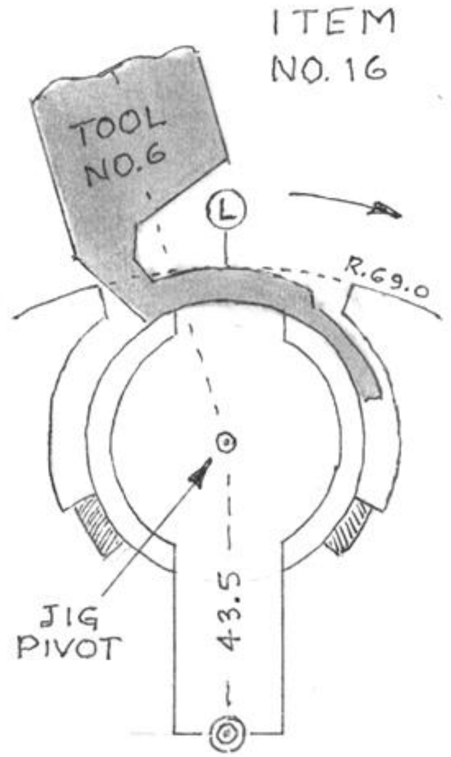
ITEM NO. 14

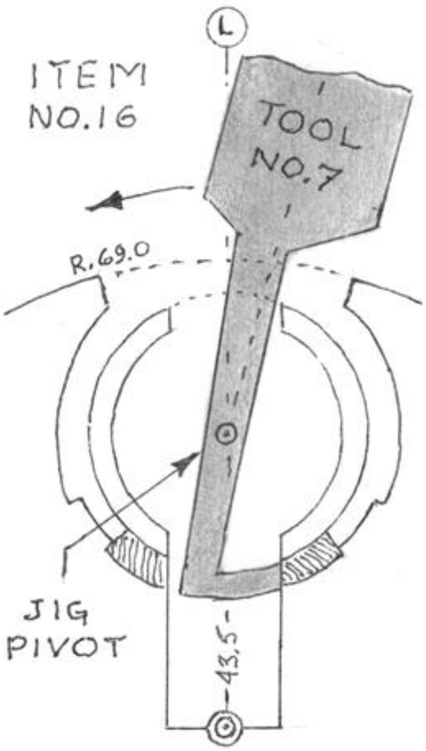


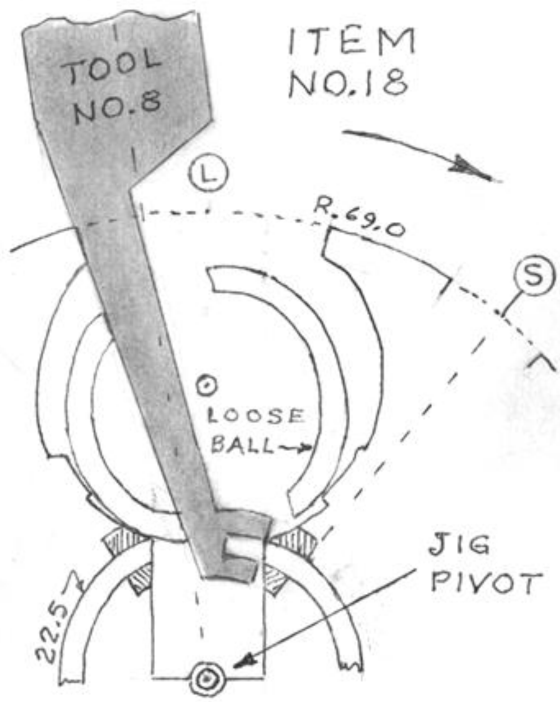
ITEM NO. 15

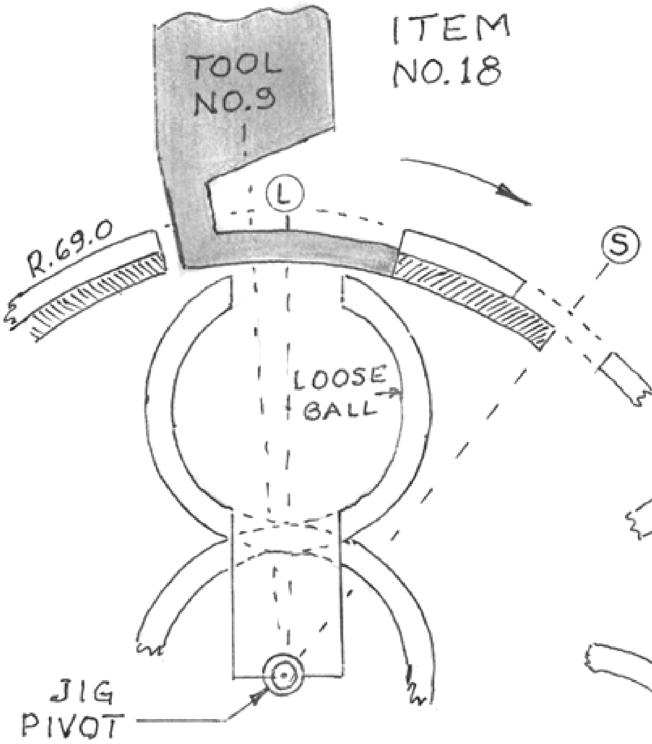


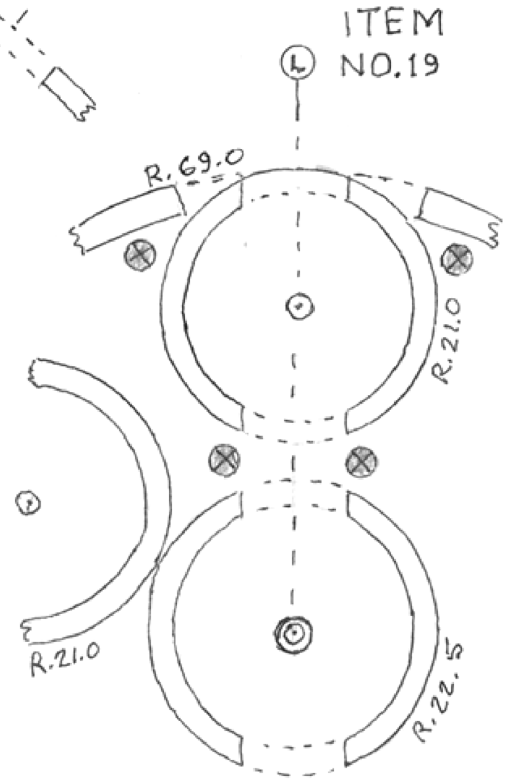

ITEM
NO.16
TOOL
NO.5
R.69.0
JIG
PIVOT
43.5

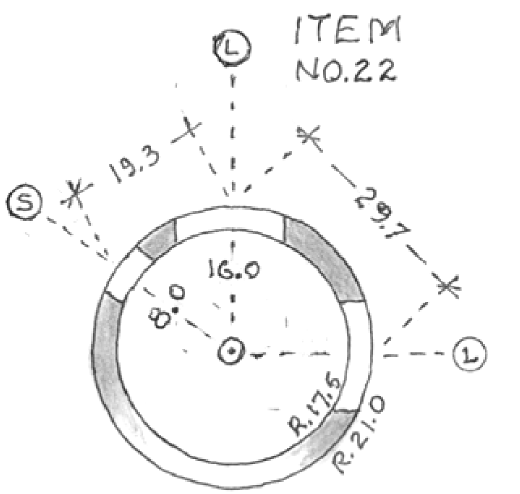

ITEM
NO. 16
TOOL
NO.6
R.69.0
JIG
PIVOT
43.5


ITEM
NO.16
TOOL
NO.7
R.69.0
JIG
PIVOT
43.5


TOOL
NO.8
ITEM
NO.18
R.69.0
LOOSE
BALL
JIG
PIVOT
22.5





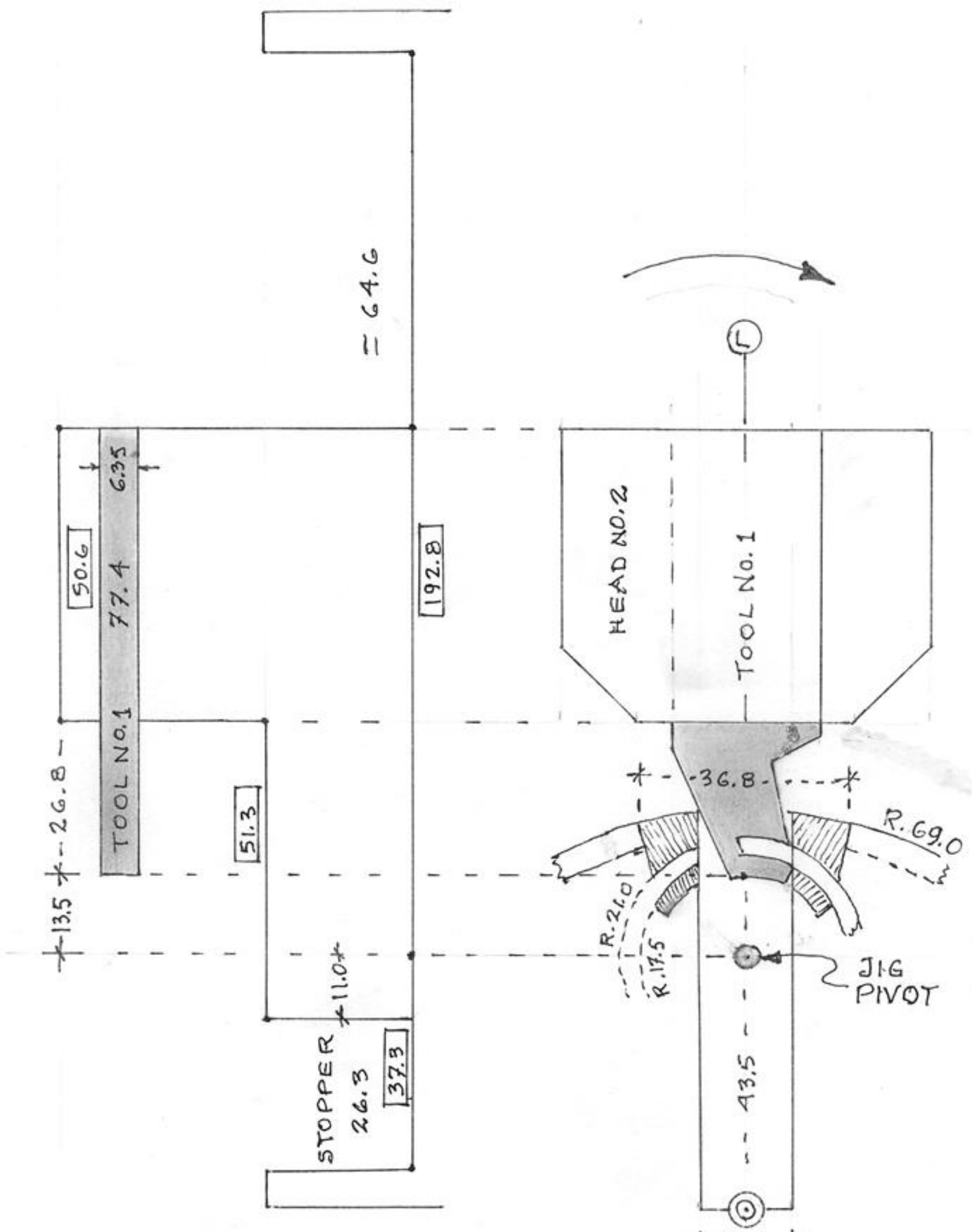


L-L = D.42.0 X 0.7071 = 29.7

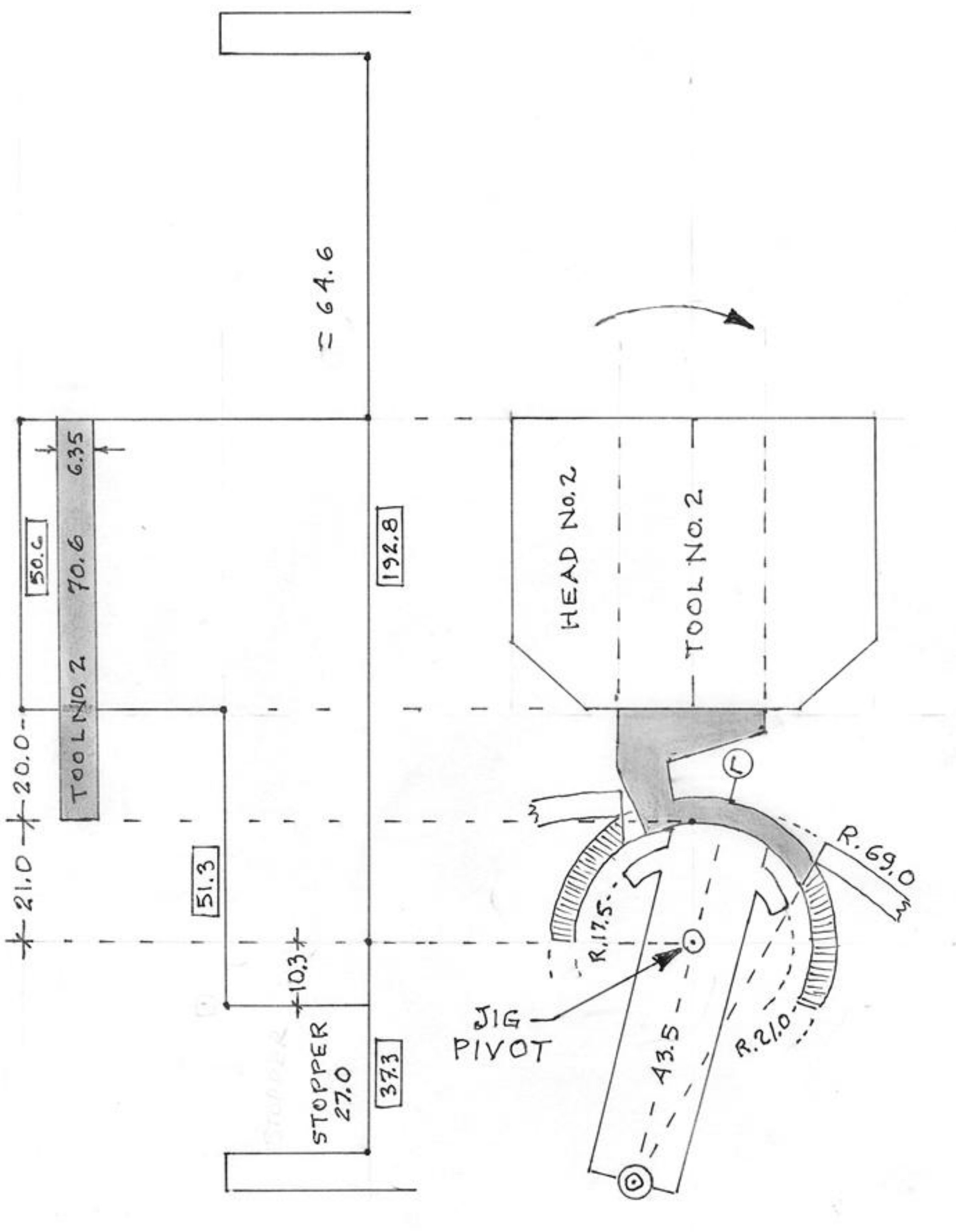
L-S = D.42.0 X 0.4597 = 19.3

Note :
When a sphere is done it will be loose so jam all 4 ⊗ locations so it will not interfere with the making of the next ones.

ITEM NO.19-1

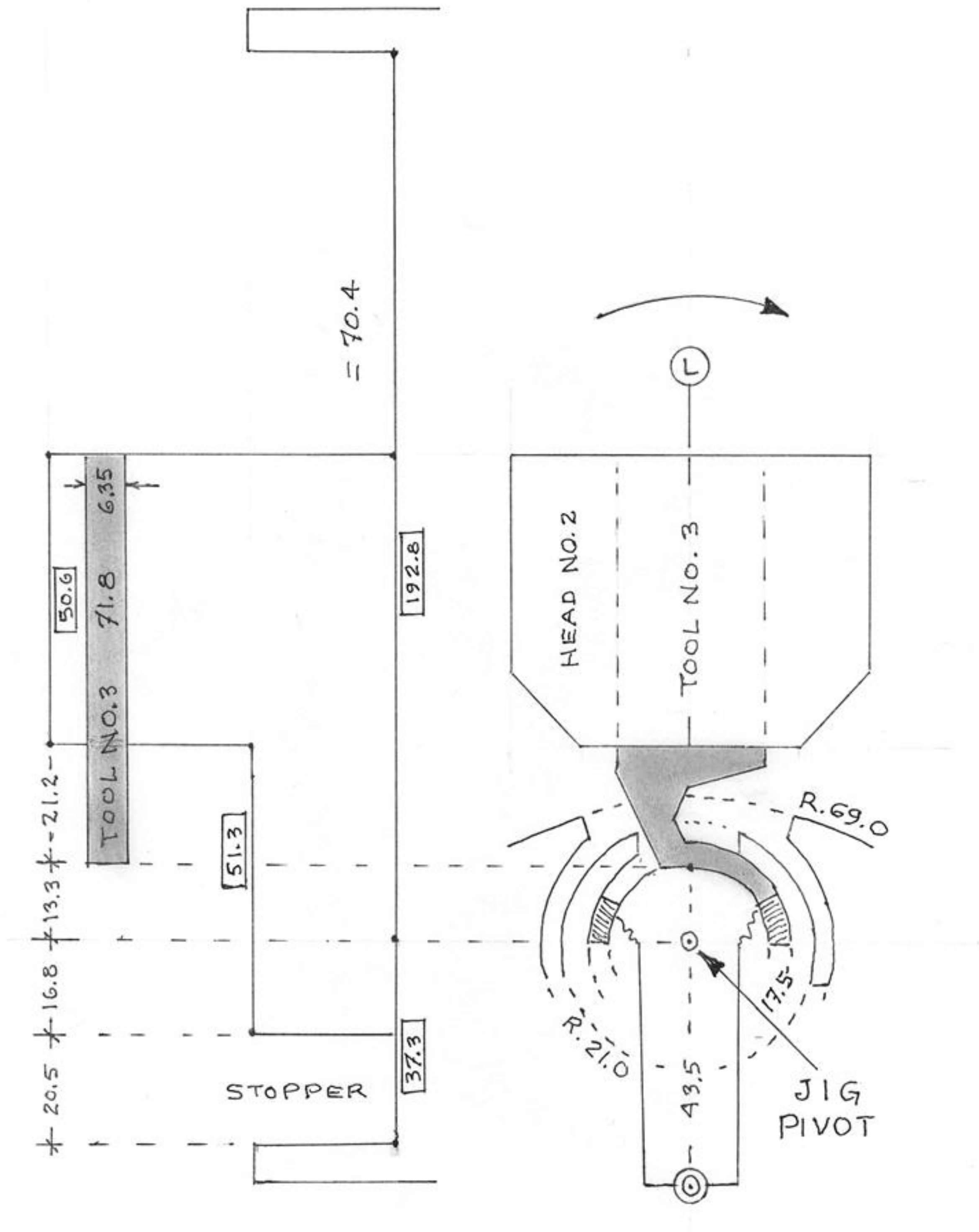

= 64.6
6.35
50.6
77.4
TOOL No.1
192.8
HEAD NO.2
TOOL No.1
26.8
13.5
51.3
36.8
R.69.0
R.21.0
R.17.5
JIG
PIVOT
11.0
STOPPER
26.3
37.3
43.5
16.0

ITEM NO.19-2



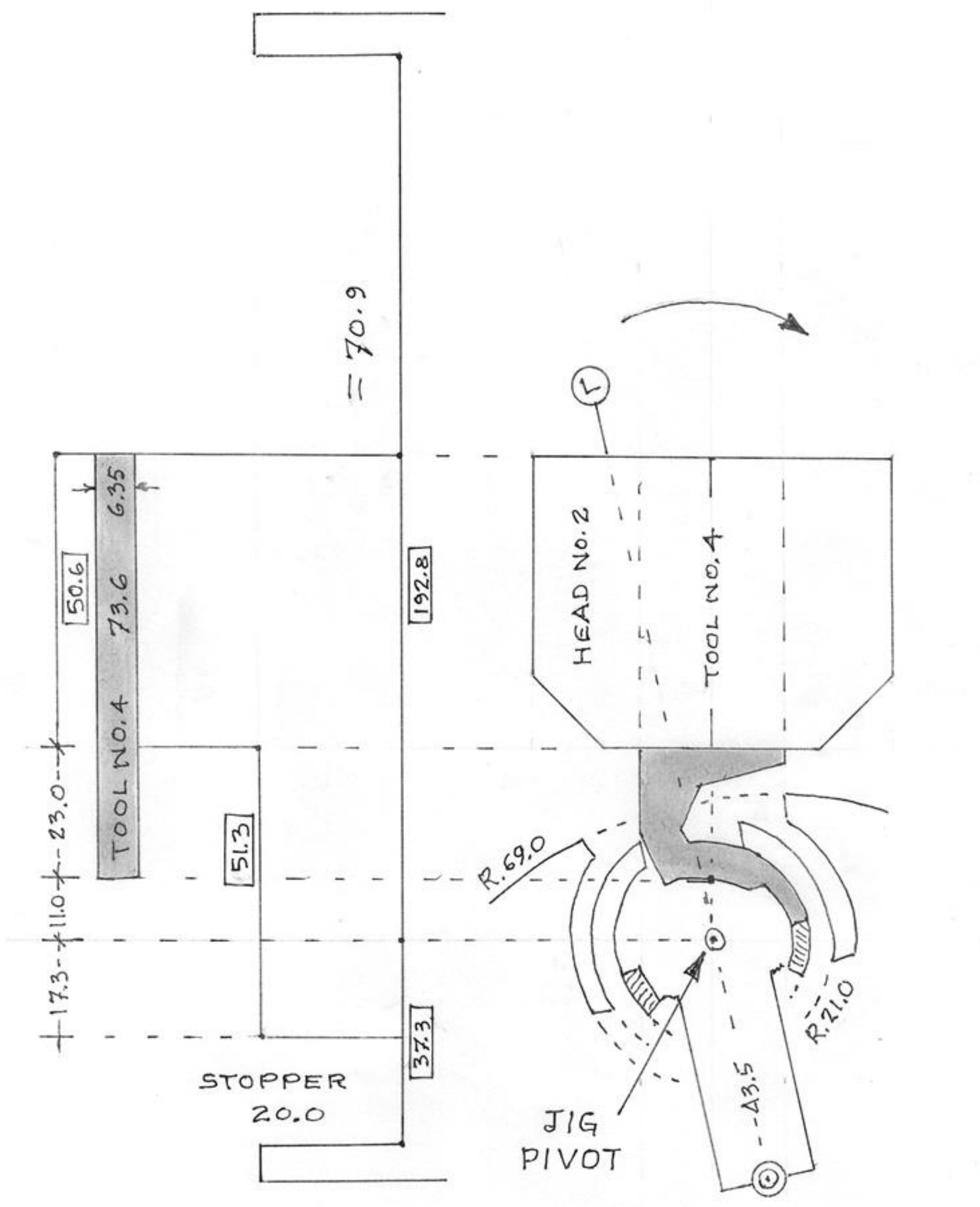
≈ 64.6
6.35
50.6
70.6
TOOL NO. 2
192.8
HEAD No. 2
TOOL No. 2
20.0
21.0
51.3
10.3
STOPPER
27.0
37.3
L
R.69.0
R.17.5
R.21.0
43.5
JIG
PIVOT

ITEM NO. 19-3



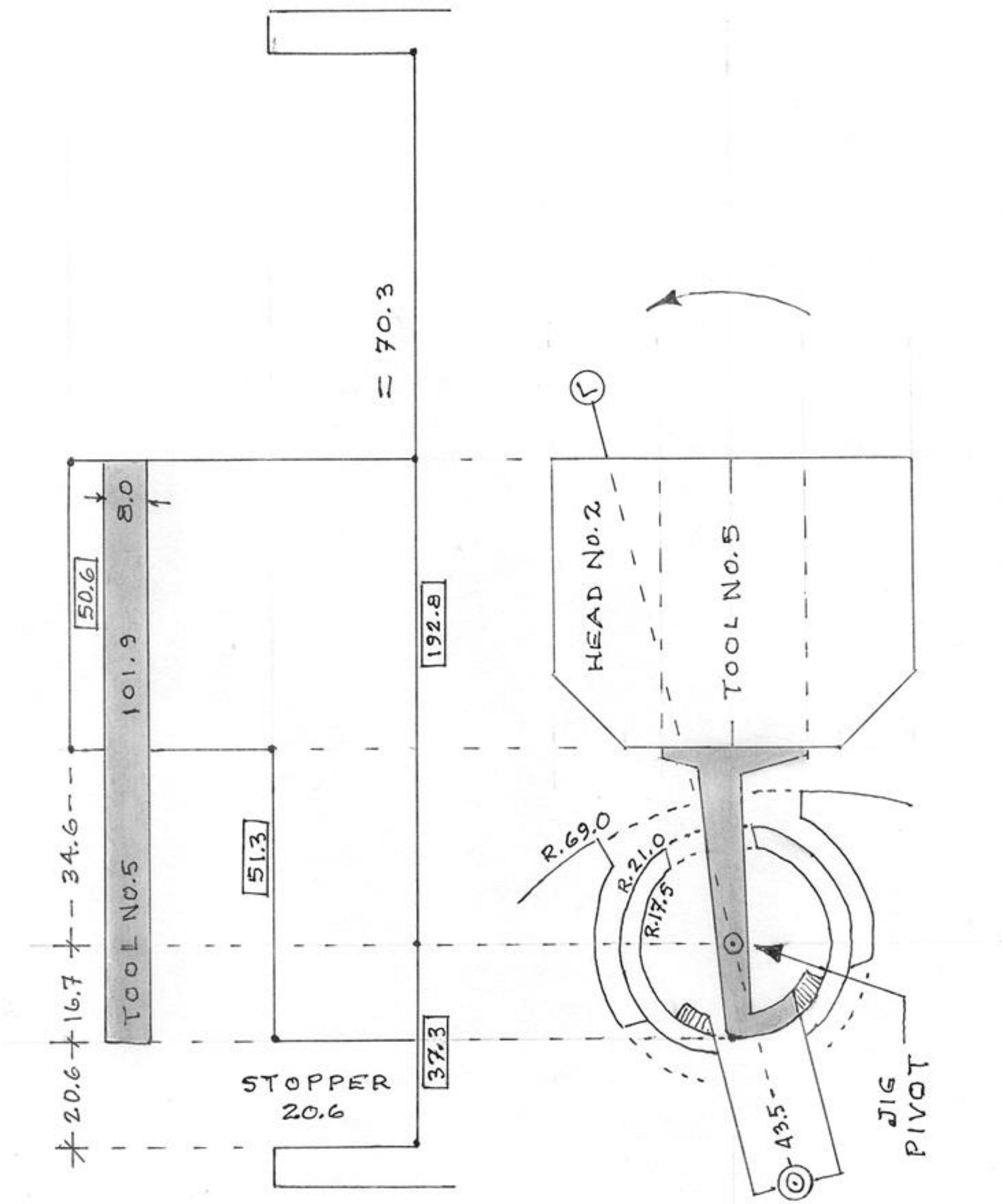
= 70.4
6.35
50.6
71.8
TOOL NO.3
192.8
HEAD NO.2
TOOL NO. 3
R.69.0
21.2
13.3
16.8
20.5
51.3
37.3
STOPPER
R. 21.0
17.5
43.5
JIG
PIVOT

ITEM NO.19-4

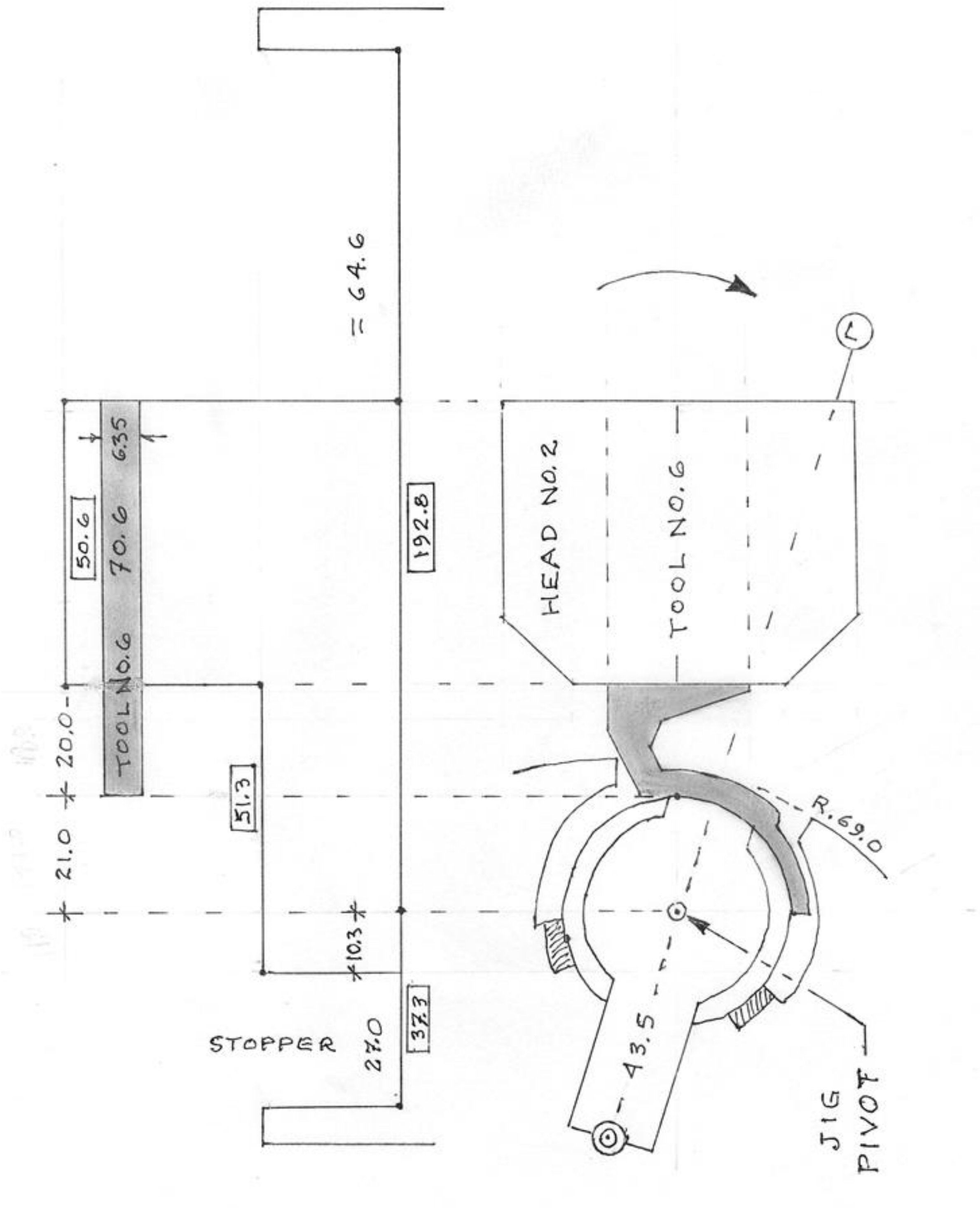


70.9
L
HEAD NO.2
TOOL NO.4
6.35
73.6
TOOL NO.4
50.6
192.8
23.0
51.3
11.0
17.3
37.3
R.69.0
R.21.0
43.5
STOPPER
20.0
JIG
PIVOT

ITEM NO. 19-5

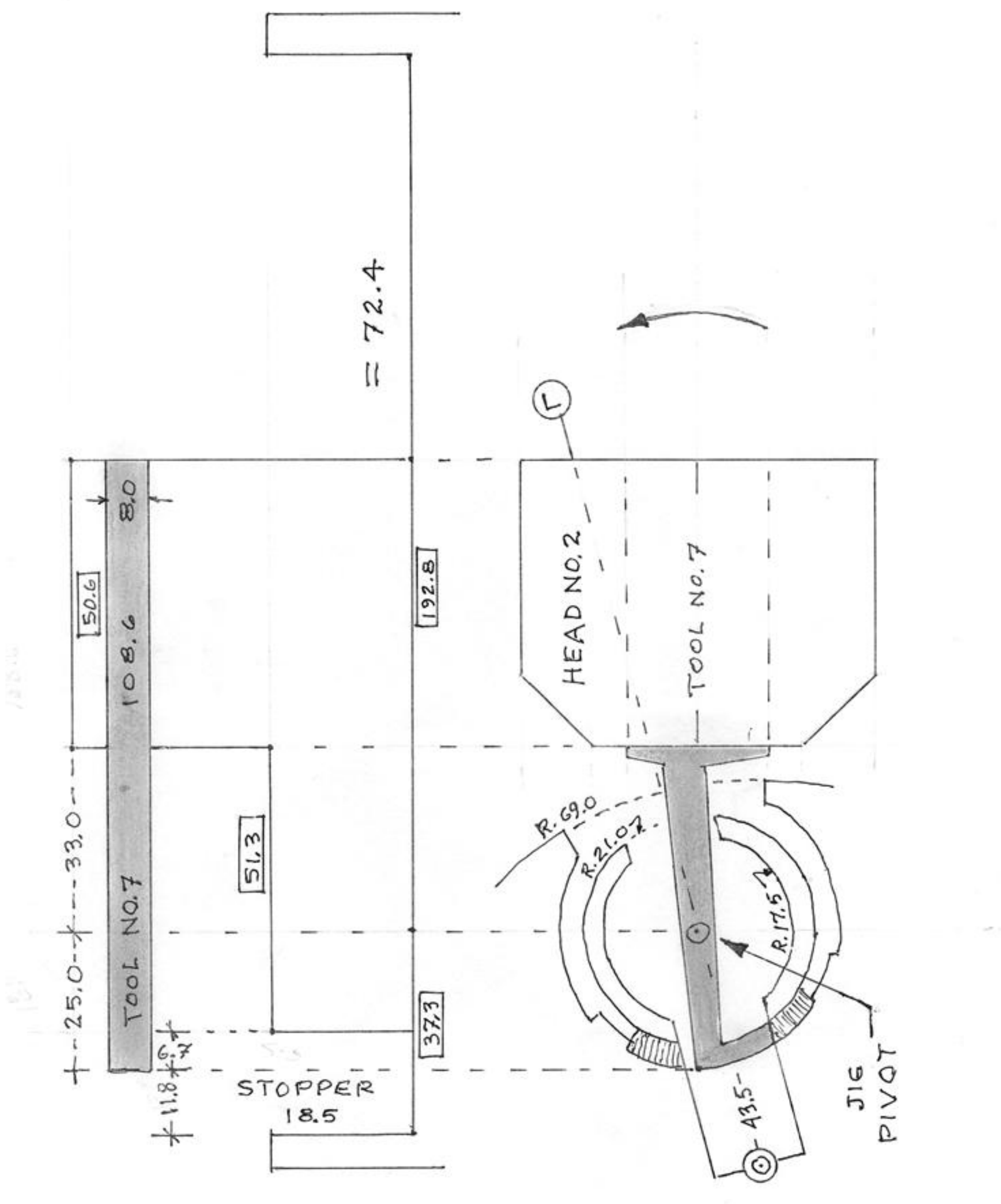

= 70.3
7
8.0
50.6
101.9
192.8
HEAD No.2
TOOL No.5
TOOL No.5
51.3
34.6
16.7
20.6
37.3
STOPPER
20.6
R.69.0
R.21.0
R.17.5
43.5
JIG
PIVOT

ITEM NO. 19-6

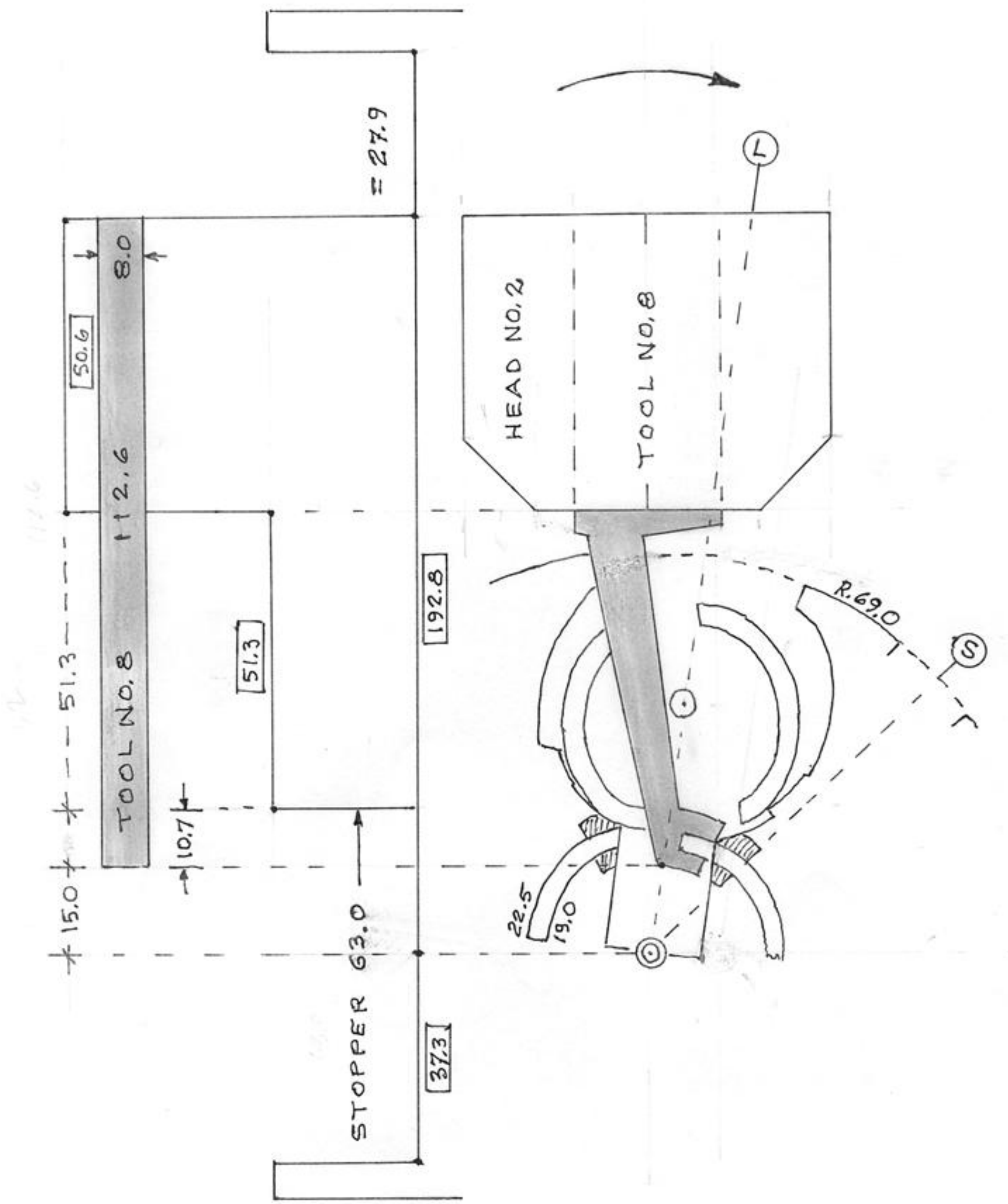


= 64.6
HEAD NO.2
TOOL NO.6
50.6
70.6
6.35
TOOL NO.6
192.8
20.0
21.0
51.3
10.3
37.3
27.0
STOPPER
R.69.0
43.5
JIG
PIVOT

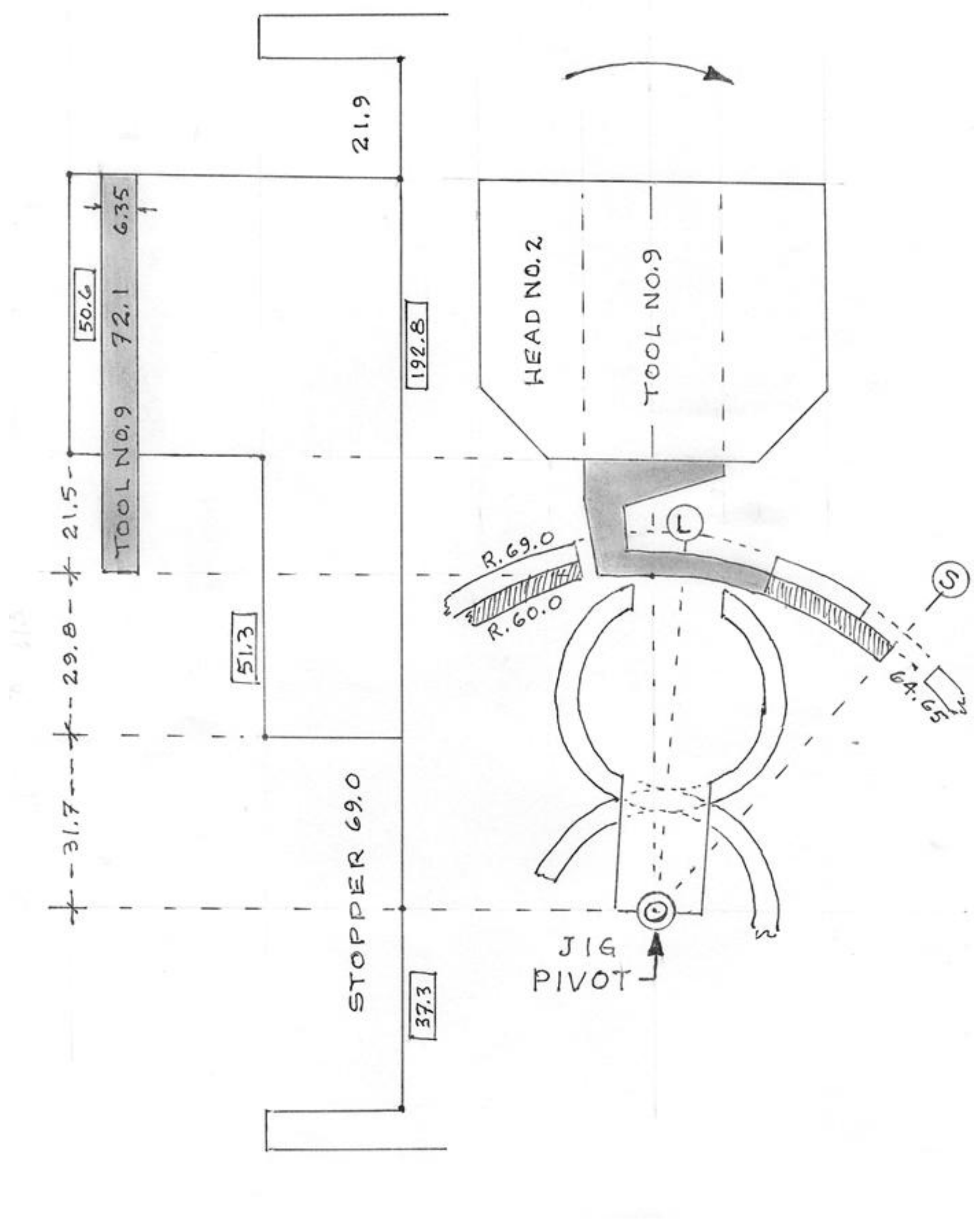
ITEM NO. 19-7


= 72.4
L
HEAD NO.2
TOOL NO.7
192.8
50.6
108.6
8.0
33.0
25.0
TOOL NO.7
51.3
37.3
6.7
11.8
STOPPER
18.5
R.69.0
R.21.0
R.17.5
43.5
JIG
PIVOT

ITEM NO.19-8

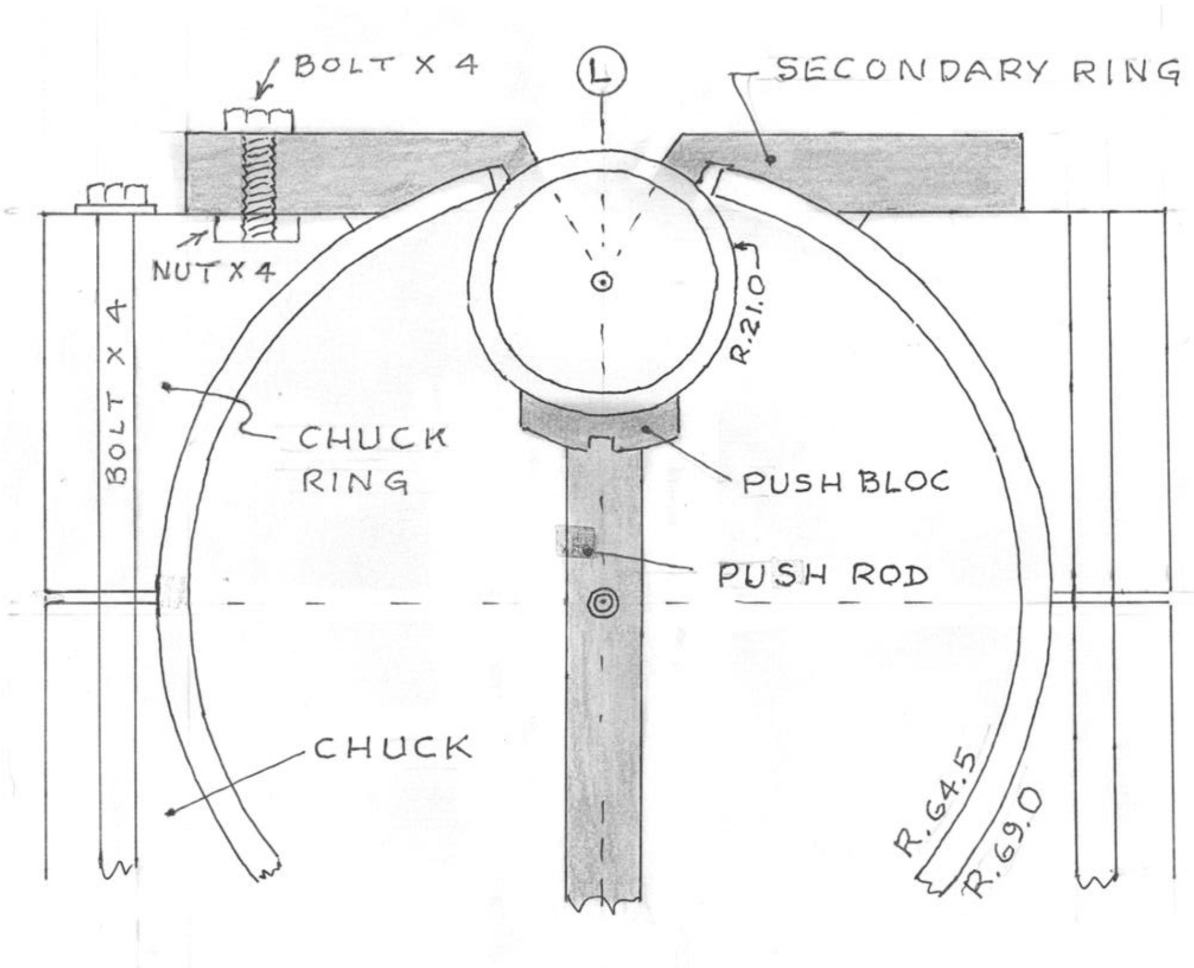

HEAD NO.2
TOOL NO.8
TOOL NO.8
112.6
50.6
8.0
51.3
51.3
10.7
15.0
192.8
= 27.9
STOPPER 63.0
37.3
R.69.0
22.5
19.0
L
S

ITEM NO. 19-9


21.9
6.35
50.6
72.1
TOOL NO.9
192.8
HEAD NO.2
TOOL NO.9
21.5
29.8
31.7
51.3
STOPPER 69.0
37.3
R.69.0
R.60.0
L
S
64.65
JIG PIVOT

ITEM NOS. 23 AND 24

USE SAME CHUCK AS "IMPLOSION"



Tour de Force

G - “Implosion”

Claude LETHIECQ

~ Implosion ~

12 point star pointing inward with a captive sphere in the middle : Icosidodecahedron.

Turned from a solid sphere nothing added or glued.

A similar piece has already been done, see “Manuel du Tourneur” 1816 by Hamelin Bergeron, page N° 192 to 194 and plate XXII. It is clearly described there that the spikes had been made separately and glued inside.

~ *Sequence of operations* ~

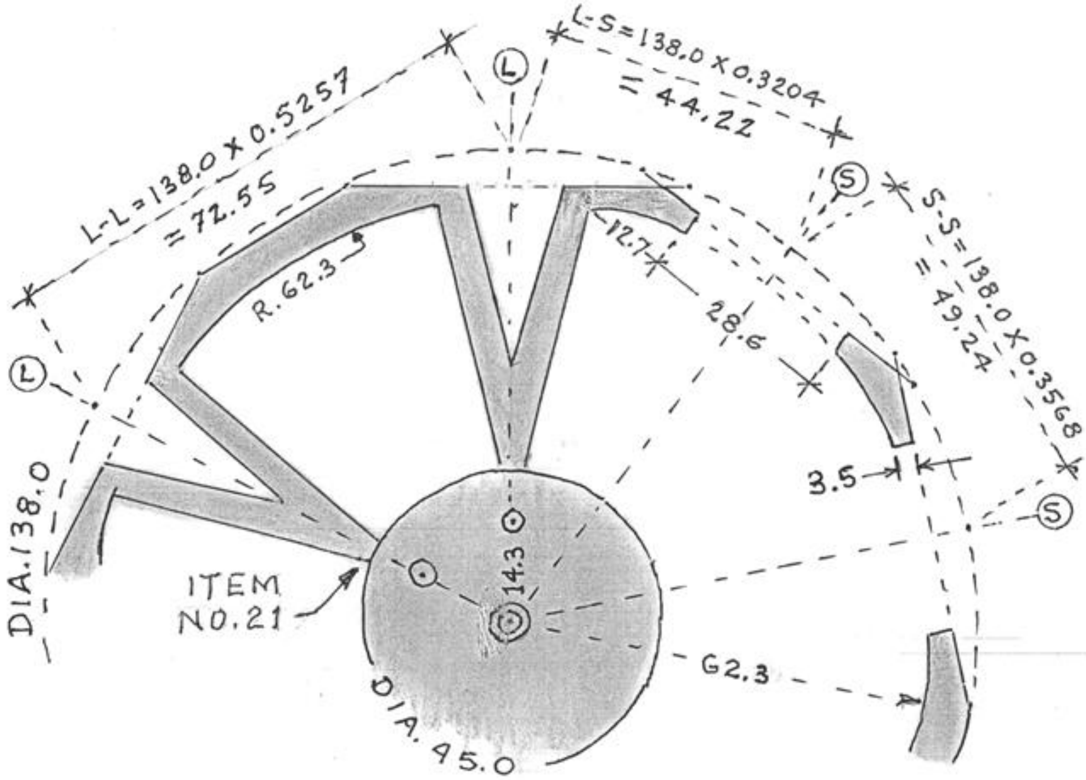
Item

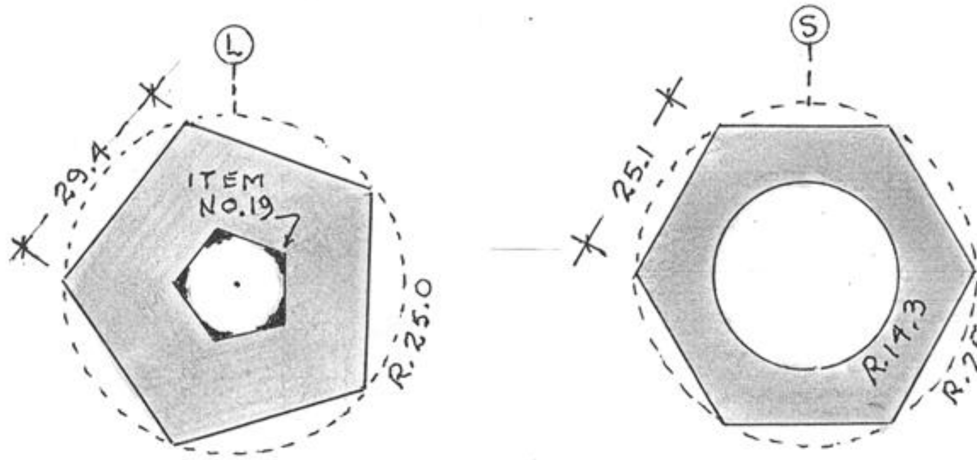
1. Draw cross-section
2. Make tool N°1 and chuck (see "contents" semi-spherical chuck for details)
3. Make tool N°2 and chuck ring (see details as mentioned in item N°2)
4. Turn sphere Ø138.0
5. Mark 12 L points and 20 S points (dodecahedron divisions)
6. Draw cutting operations and tool N°3. Make tool N°3
7. Set sphere in chuck and ring. Line up an L point and cut flat as per $\boxed{A}$
8. Use tool N°3 as per $\boxed{B}$ in item N°6 and set in sphere jig as per item N°9
9. Make "cap" with soft wood held with double face tape and turn to regain original shape of a full sphere to replace what was cut off in $\boxed{A}$
10. Repeat items N°7, 8 and 9 until all 12 L points are done
11. Draw and make tools N°4, 5, 6 and 7
12. Make cutting operation $\boxed{C}$ and $\boxed{D}$ item N°6 (do not replace with a "cap"

13. Use tool N°4, 5, 6 and 7 as per $\boxed{E}$, $\boxed{F}$, $\boxed{G}$ and $\boxed{H}$ item N°11. Set in sphere jig as per items N°14 to 17
14. Repeat items N°11 to 13 till all 20 S points are done
15. Remove all caps
16. Sand corners of the 12 Ⓛ conical holes to a pentagonal shape (see x-section)
17. Sand flat each face of the 5 faces of the 12 inward spikes
18. Separate small end of each 12 inward spikes to free captive sphere (as thin as possible)
19. Sand captive sphere as round as possible

ITEM NO. 1

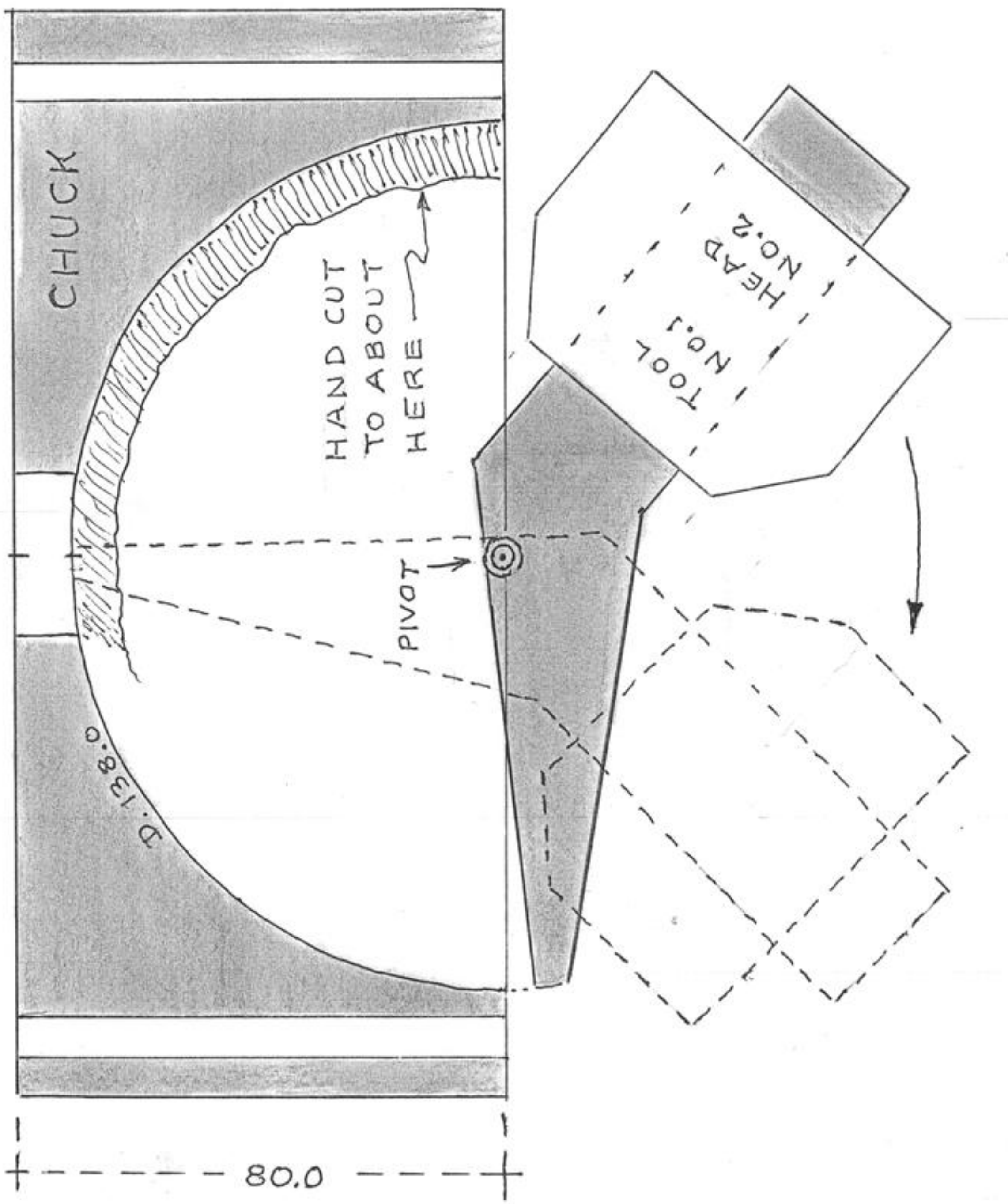
~CROSS-SECTION~





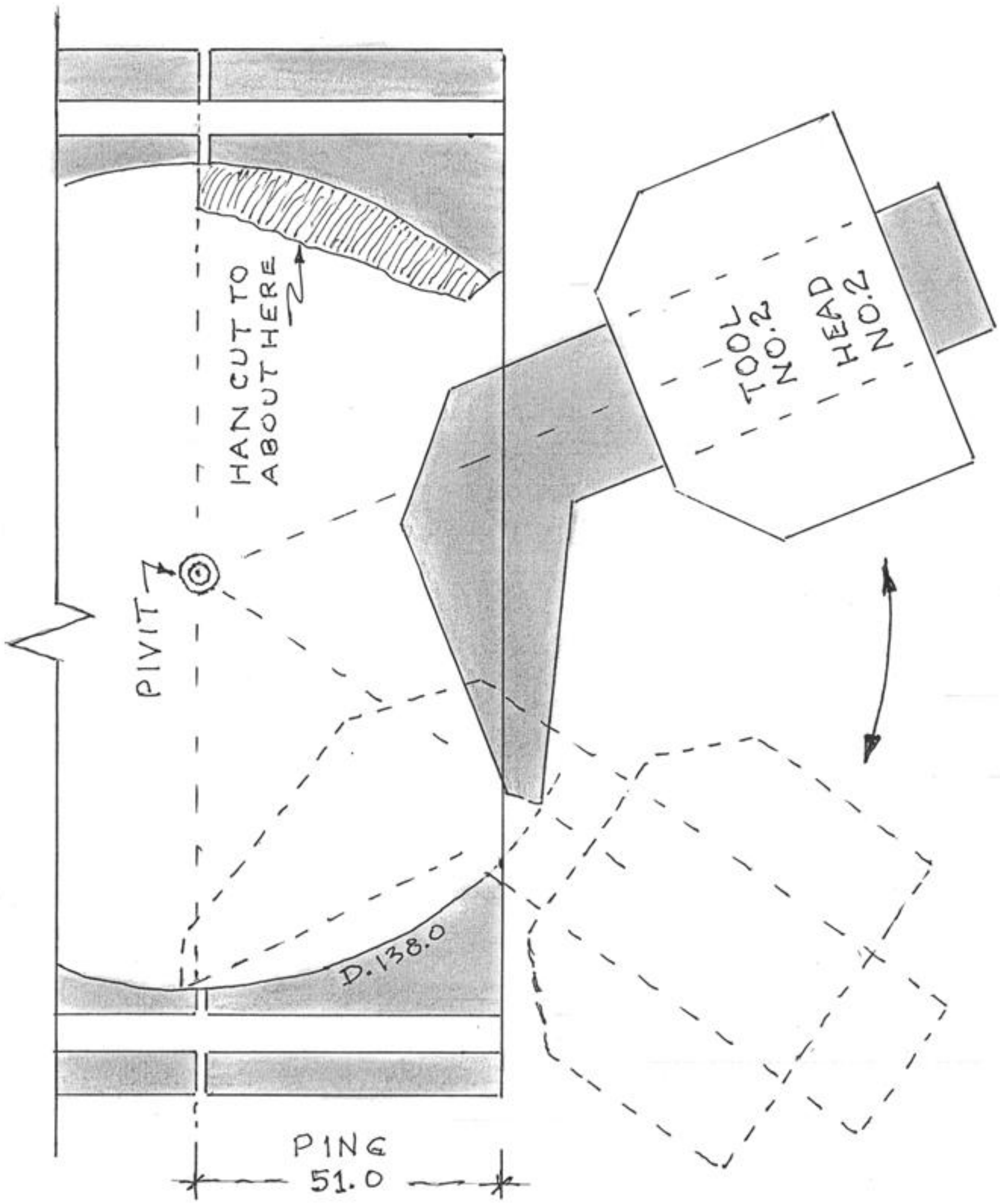
ITEM NO. 2

FOR DETAILS SEE "CONTENTS" SEMI-SPHERICAL CHUCK

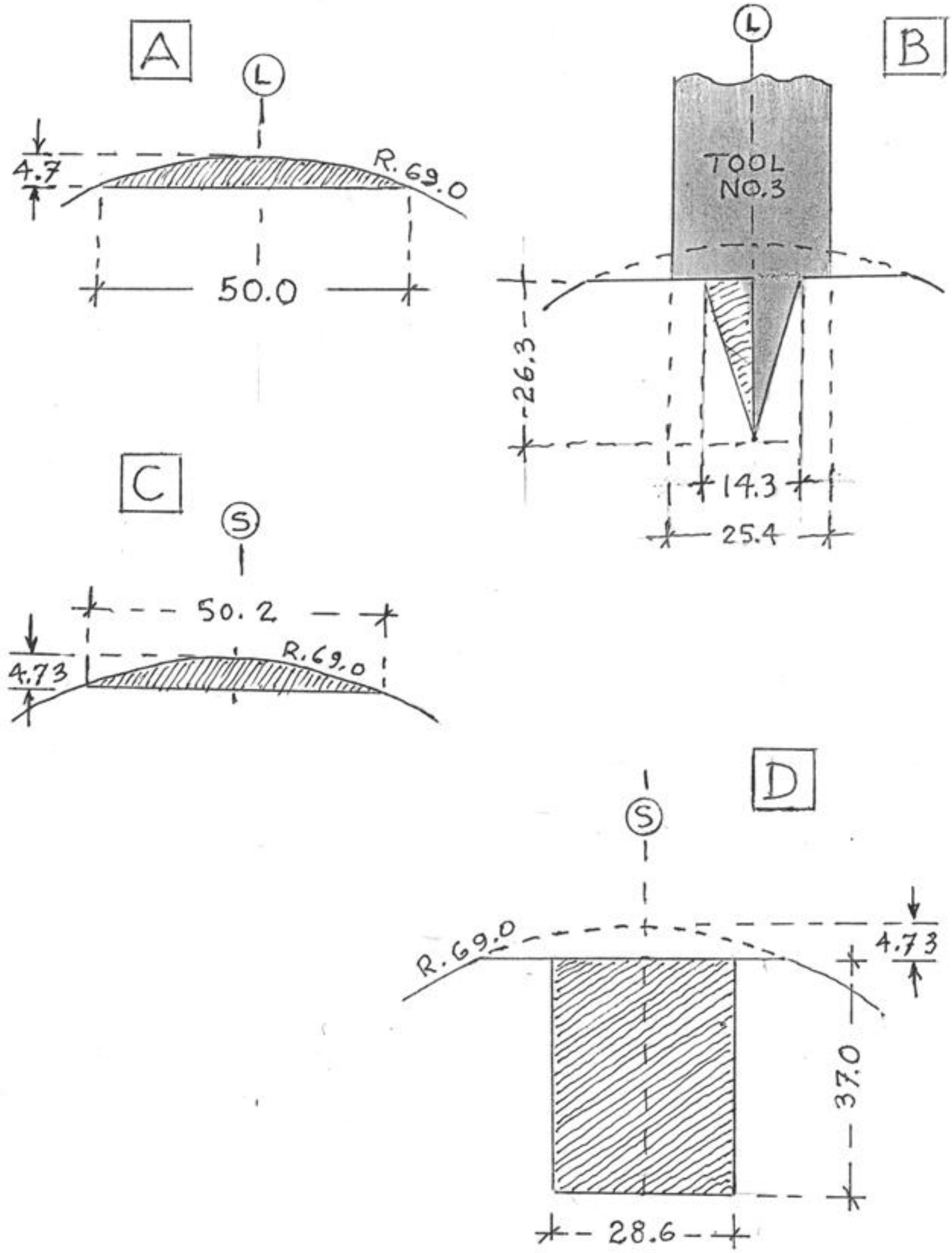


ITEM NO.3

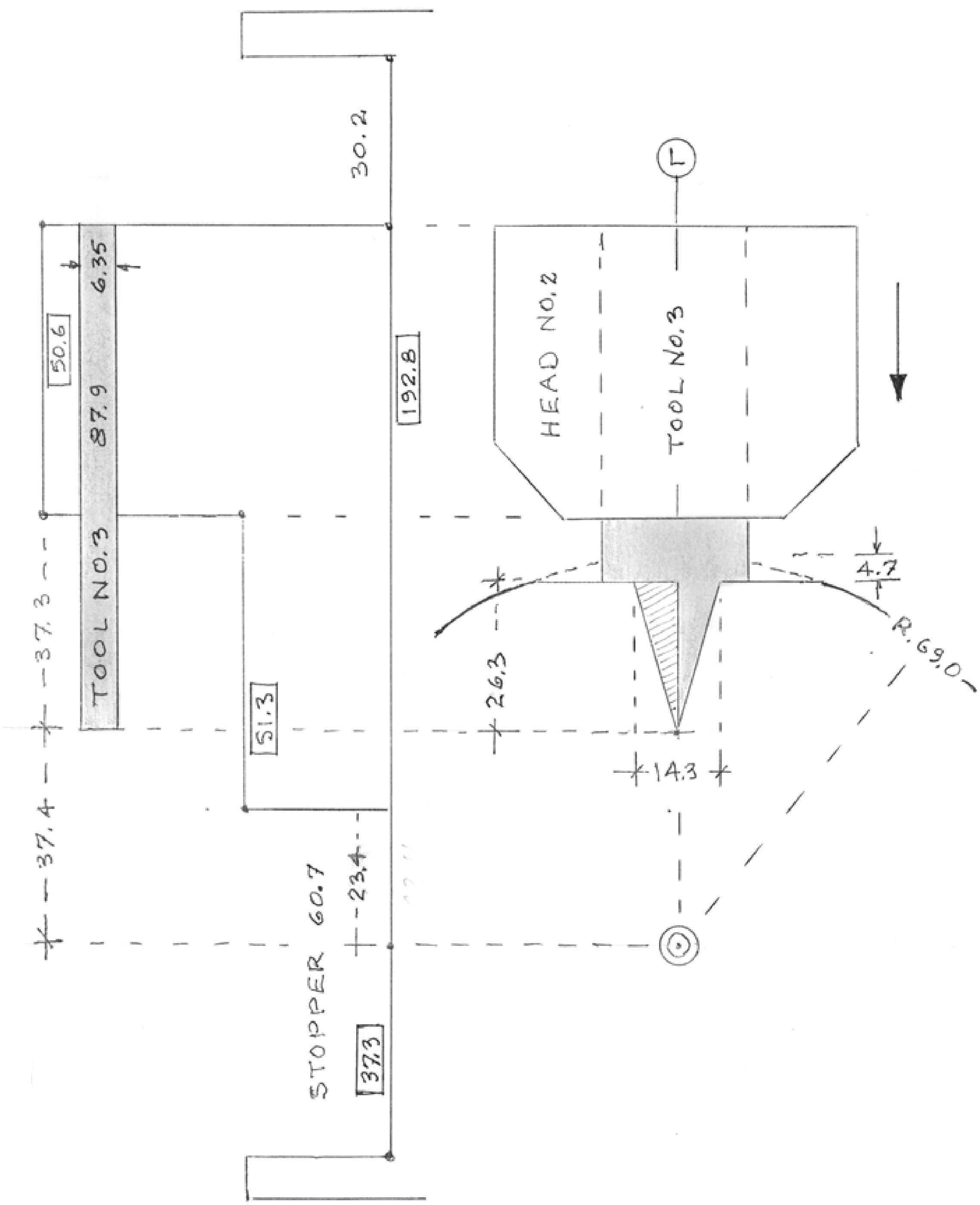
FOR DETAILS SEE
"CONTENTS" SEMI-
SPHERICAL CHUCK



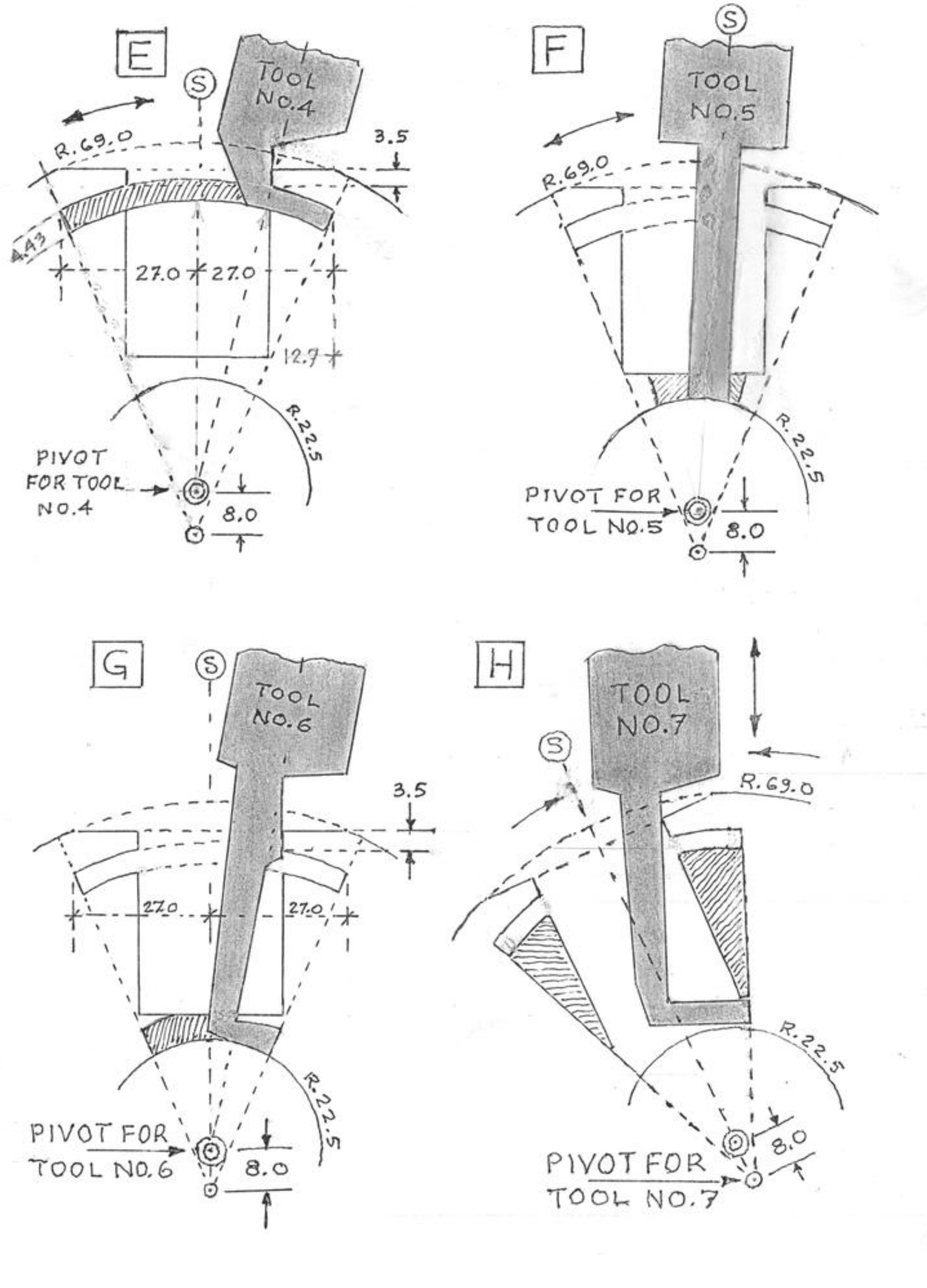
ITEM NO.6


A
L
4.7
R.69.0
50.0
B
L
TOOL
NO.3
26.3
14.3
25.4
C
S
50.2
4.73
R.69.0
D
S
R.69.0
4.73
37.0
28.6

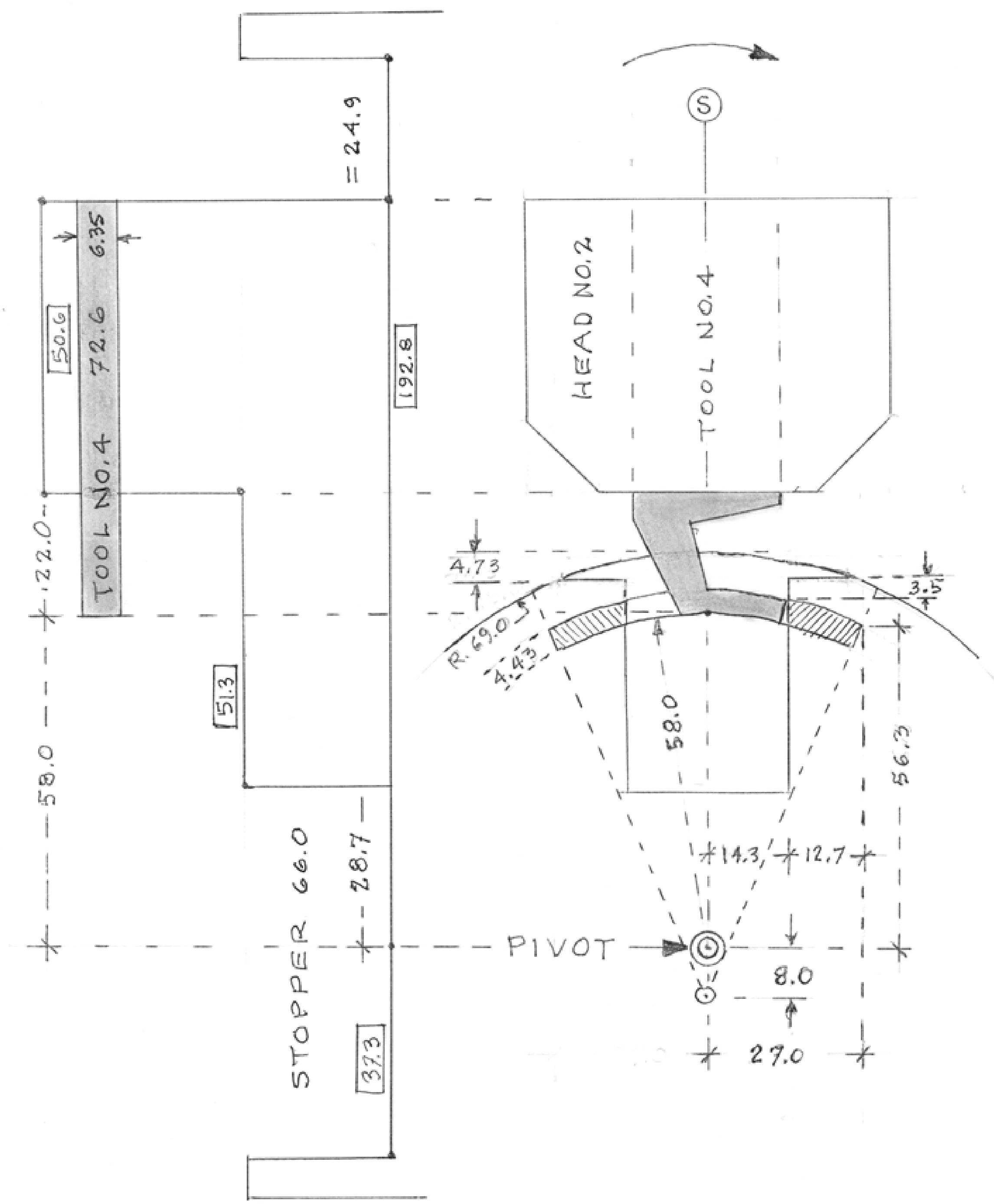
ITEM NO. 9


30.2
HEAD NO.2
TOOL NO.3
TOOL NO.3
6.35
87.9
50.6
192.8
37.3
37.4
51.3
26.3
14.3
4.7
R. 69.0
STOPPER 60.7
23.4
37.3

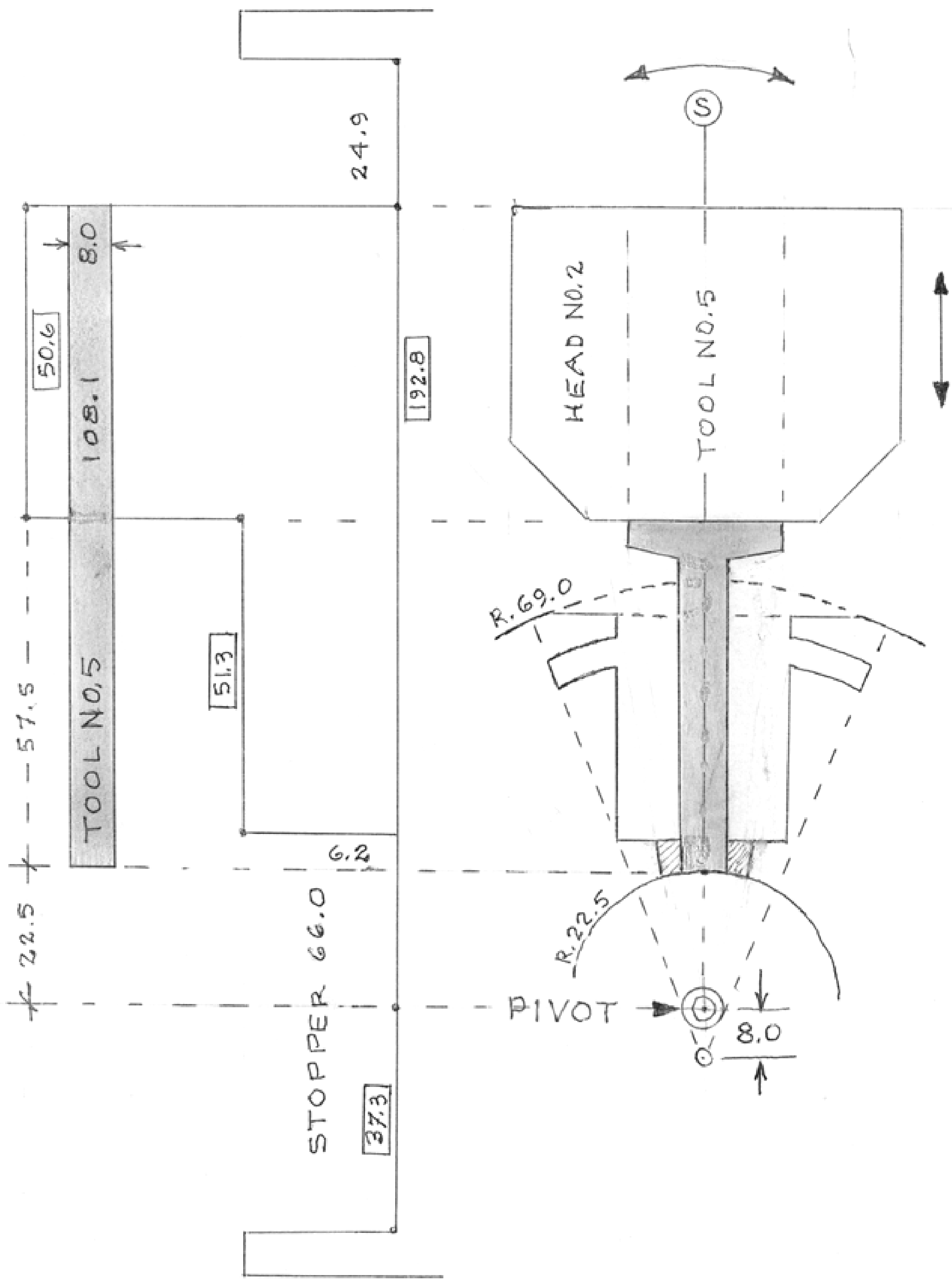
ITEM NO. 11


E
S
TOOL No.4
R.69.0
3.5
4.43
27.0
27.0
12.7
R.22.5
PIVOT FOR TOOL NO.4
8.0
F
S
TOOL NO.5
R.69.0
R.22.5
PIVOT FOR TOOL NO.5
8.0
G
S
TOOL NO.6
3.5
27.0
27.0
R.22.5
PIVOT FOR TOOL NO.6
8.0
H
S
TOOL NO.7
R.69.0
R.22.5
8.0
PIVOT FOR TOOL NO.7

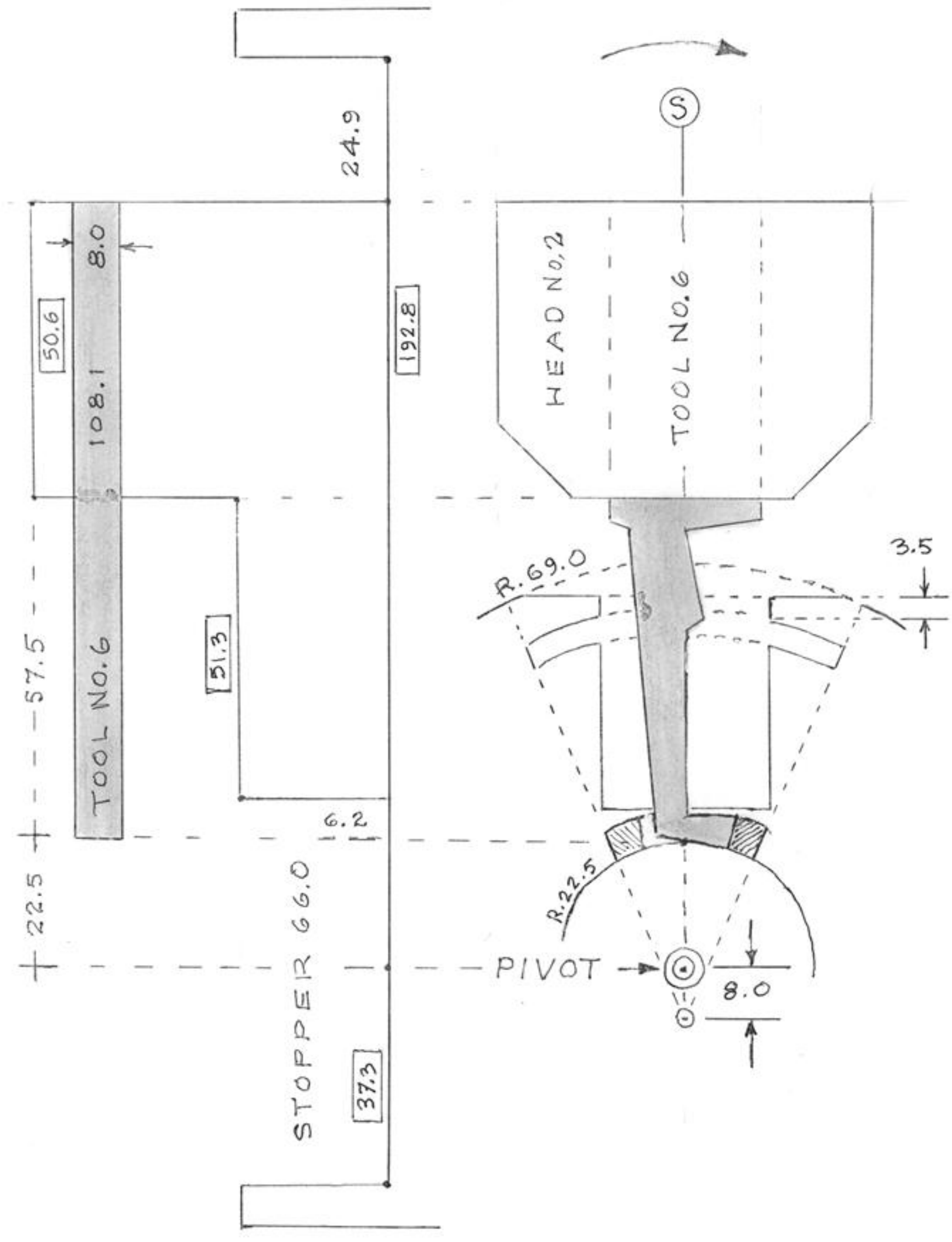
ITEM NO. 14


S
HEAD NO.2
TOOL NO.4
24.9
192.8
50.6
72.6
6.35
TOOL NO.4
122.0
58.0
51.3
STOPPER 66.0
28.7
37.3
PIVOT
4.73
R. 69.0
4.43
58.0
3.5
56.3
14.3
12.7
8.0
27.0

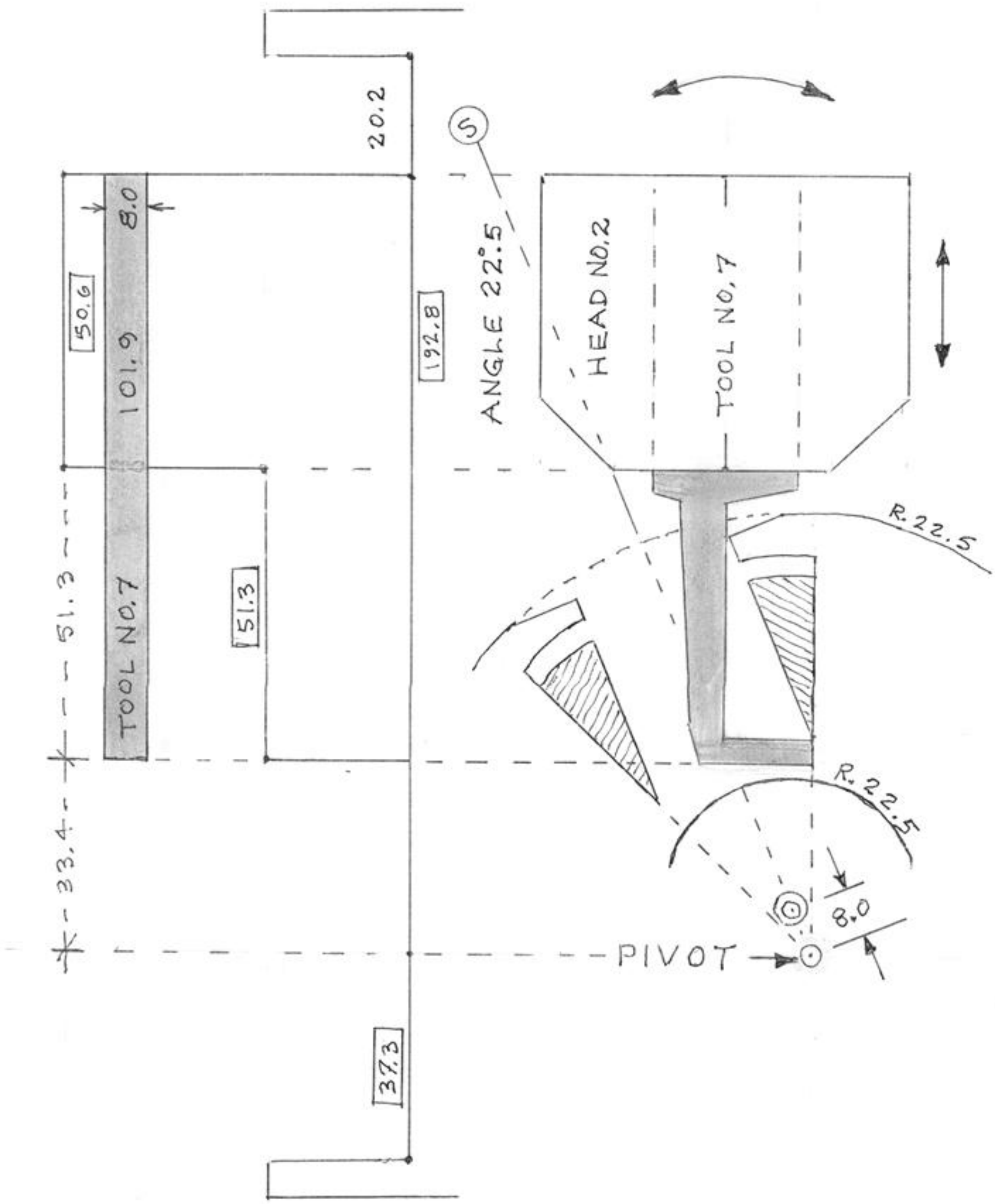
ITEM NO. 15


S
24.9
8.0
50.6
108.1
192.8
HEAD NO.2
TOOL NO.5
R. 69.0
51.3
57.5
TOOL NO.5
6.2
22.5
R. 22.5
STOPPER 66.0
PIVOT
8.0
37.3

ITEM NO. 16


S
24.9
8.0
50.6
108.1
192.8
HEAD NO.2
TOOL NO.6
R.69.0
3.5
57.5
51.3
TOOL NO.6
6.2
22.5
R.22.5
STOPPER 66.0
PIVOT
8.0
37.3

ITEM NO. 17



20.2
S
8.0
50.6
101.9
192.8
ANGLE 22°.5
HEAD NO.2
TOOL NO.7
TOOL NO.7
51.3
51.3
R.22.5
R.22.5
33.4
8.0
PIVOT
37.3

Tour de Force

H - “Surprise”

Claude LETHIECQ

~ Surprise ~

Spiked dodecahedron in 2 concentric spheres in a bowl and cover with extra long stem in a dodecahedron.

All in one piece, nothing added

~ Sequence of operations ~

Item

1. Draw x-section
2. Make tool N°1 to 10 included
3. Make chuck
4. Make chuck ring
5. Drill Ø35.0 hole in chuck and in ring
6. With the bloc between centers turn of hatched section
7. Invert turning, set Ø47 hub in your chuck, set jig pivot and with head N°1 turn R.67 sphere up to hub
8. With turning still in your chuck mark Ⓛ^{1} and 2 Ⓛ^{2} (dodecahedron) cut hatched section
9. Make and set “cap” and use tool N°3
10. Use tool N°4
11. Use tool N°5
12. Reset jig pivot at 48.0 from end of small hub and use tool N°6
13. With turning in semi-spherical chuck line up Ⓛ^{2} and cut hatched section
14. To set jig pivot : measure total length of the piece from end of the foot to the end of the long stem minus 67.0 = distance of pivot from end of the stem. Set a cap and use tool N°7
15. Use tool N°8 and set wedges as per item N°12
16. Set turning so the stem is through openings in the ring, line up Ⓛ^{3}, cut flat Ⓢ^{3} to Ⓢ^{3} , set cap and use tool N°9 and mark Ⓛ^{3} on R.51
17. Use tool N°10 and set wedges as per item N°12
18. Rotate turning to the next Ⓛ point and repeat items N°16 & 17 till all 5 faces towards stem are done
19. Invert turning so the stem is through openings in the chuck and again repeat items N°16 & 17 till all 5 faces towards the foot are done

20. The dodecahedron is now separated, take off all wedges
21. Make a support fixed on the lathe bed to support and hold the dodecahedron stationary
22. Set the turning between centers and adjust the dodecahedron on the support to permit the free rotation of the R.51 sphere
23. Details of different pivot points and the location of an opening
24. To set jig pivot : same as item N°14
25. Set pivot 8.0 above center and use tools N° 11 & 12
26. Set pivot 8.0 + 4.0 above center and use tools N° 13 & 14
27. Fix loose cover to the dodecahedron, reset pivot 8.0 above center and use tool N°15
28. Use tool N°16 then back off same tool in head N° 2 just to clear R.34 line, make on pass and then use tool N°17
29. Now that the R.27 sphere is separated move it as far as possible and fix it to the cover. Set pivot 4.0 below center and use tool N°18, then cut hatched section by hand
30. Use tools N°19, then N°20 held in hand and then use tool N°21
31. General setup to turn inside Ø 54.0 sphere
32. Make push block and 2 pieces cup
33. Make secondary ring
34. Draw cross-section of R.27.0 sphere (spiked dodecahedron inside 2 concentric spheres), draw tools N° 22 to 25 to be used on secondary ring
35. Make tools of item N°34 and 11 plugs
36. Mark 12 Ⓛ points on R.27.0 sphere
37. Set R.27.0 sphere in chuck as per item N°31
38. Set jig pivot at center of R27.0 sphere
39. Line up an Ⓛ point and use tools N° 22, 23 and 24 and plugs. Repeat this item till all 12 Ⓛ points are done
40. Make a base, if similar to mine notice the magnet for security, very tipsy.

ITEM NO.1

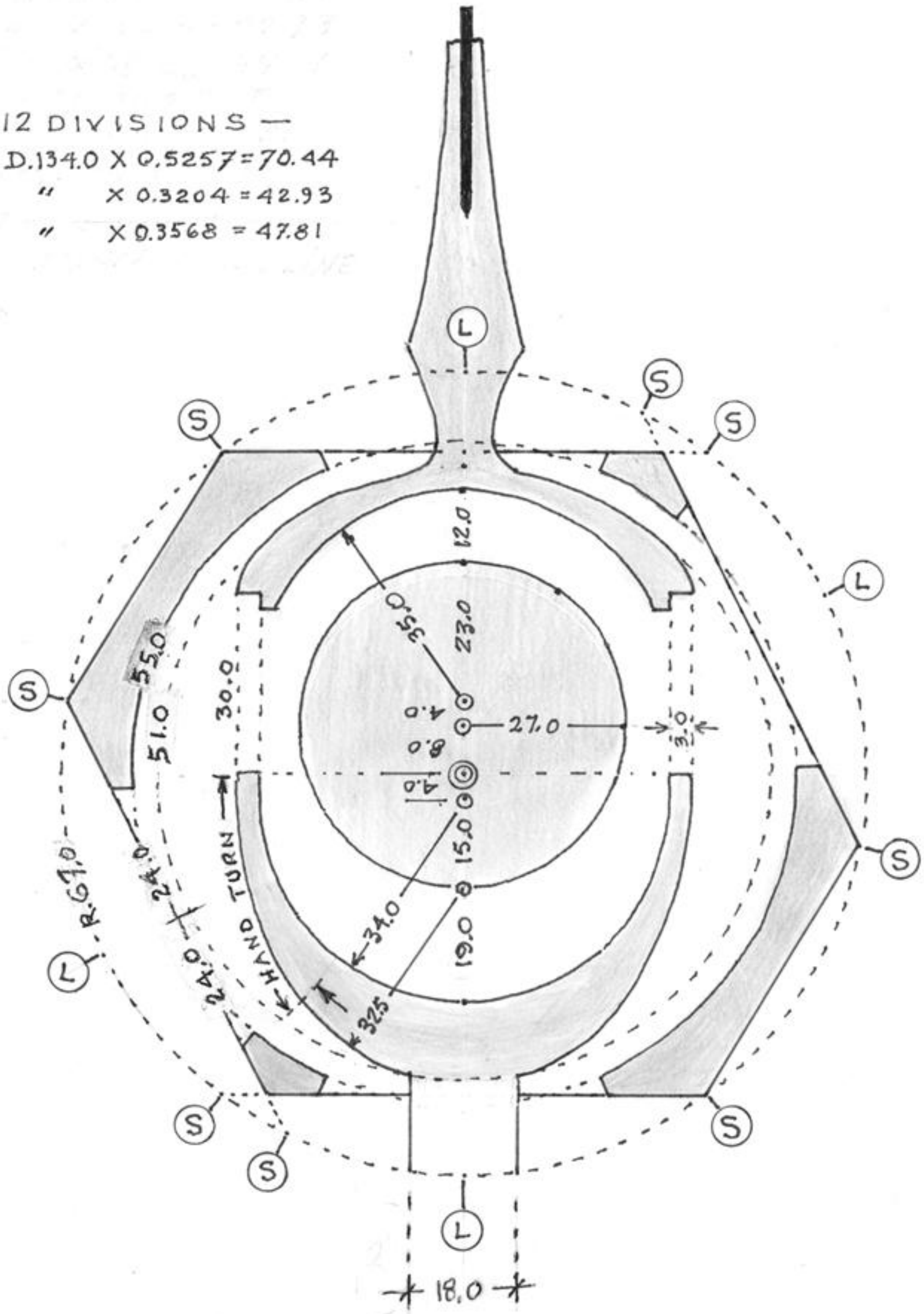
CROSS-SECTION

— 12 DIVISIONS —

L-L = D.134.0 X 0.5257 = 70.44

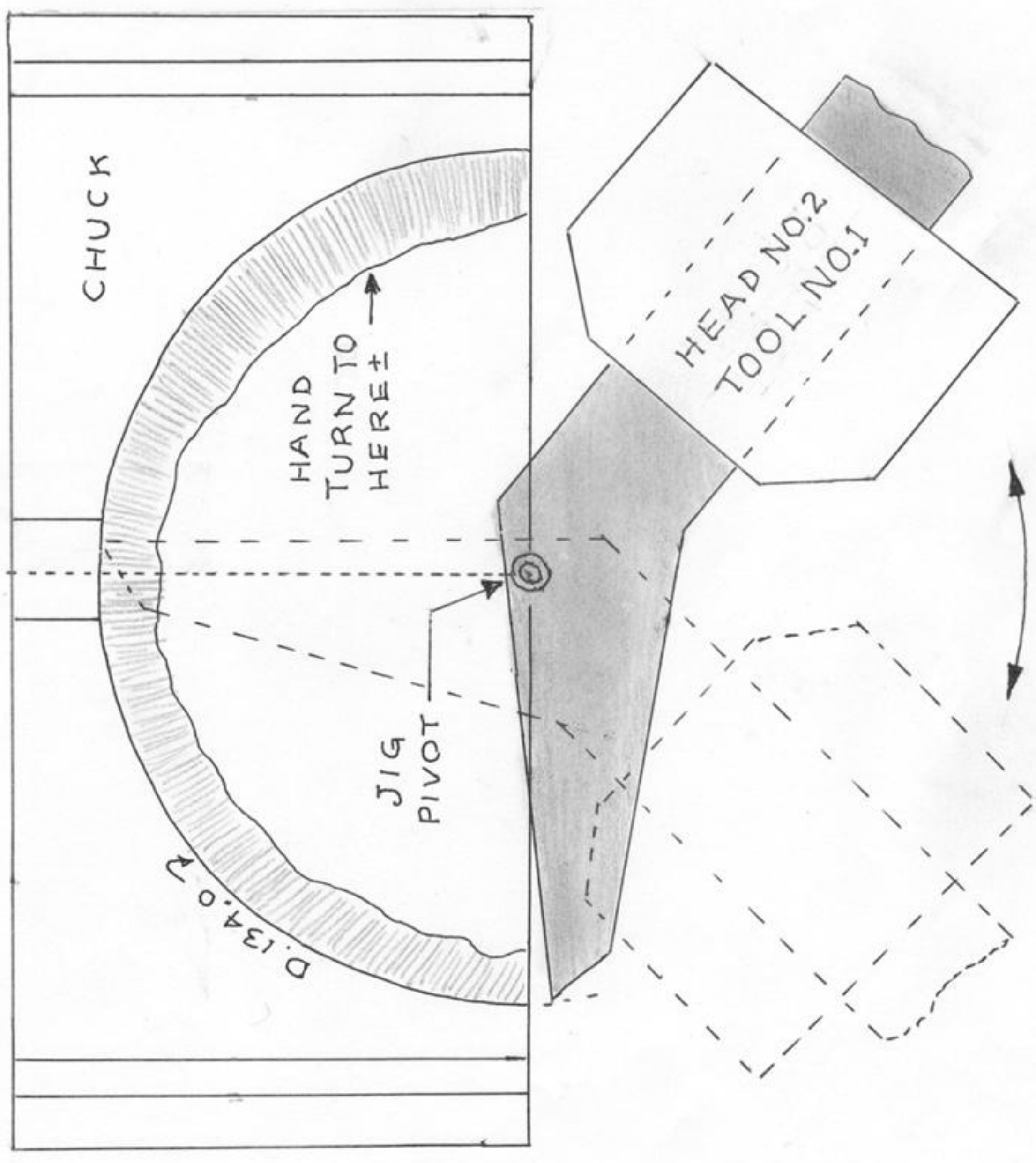
L-S = 〃 X 0.3204 = 42.93

S-S = 〃 X 0.3568 = 47.81



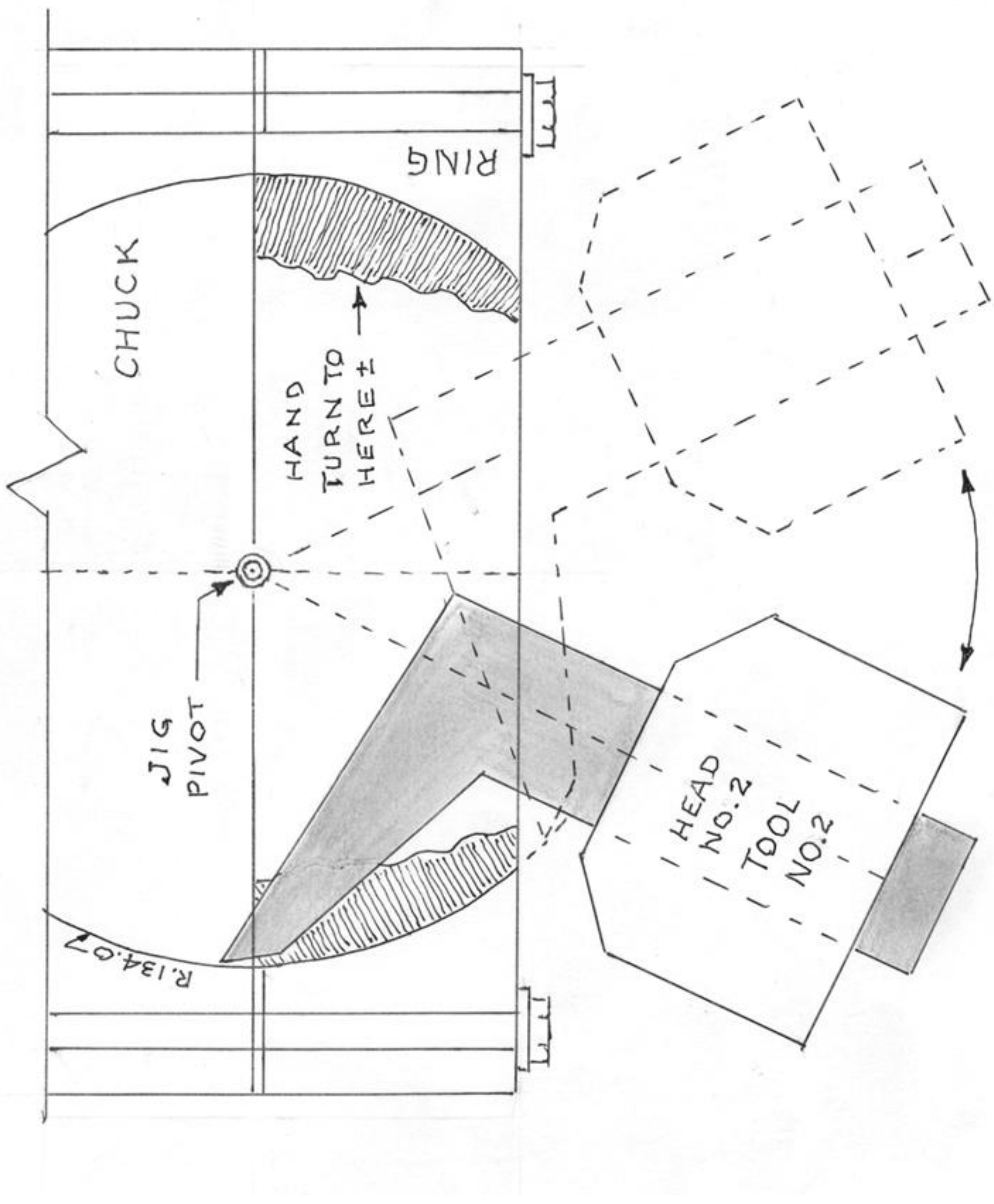
ITEM NO. 3

FOR DETAILS SEE "CONTENTS" SEMI-SPHERICAL CHUCK

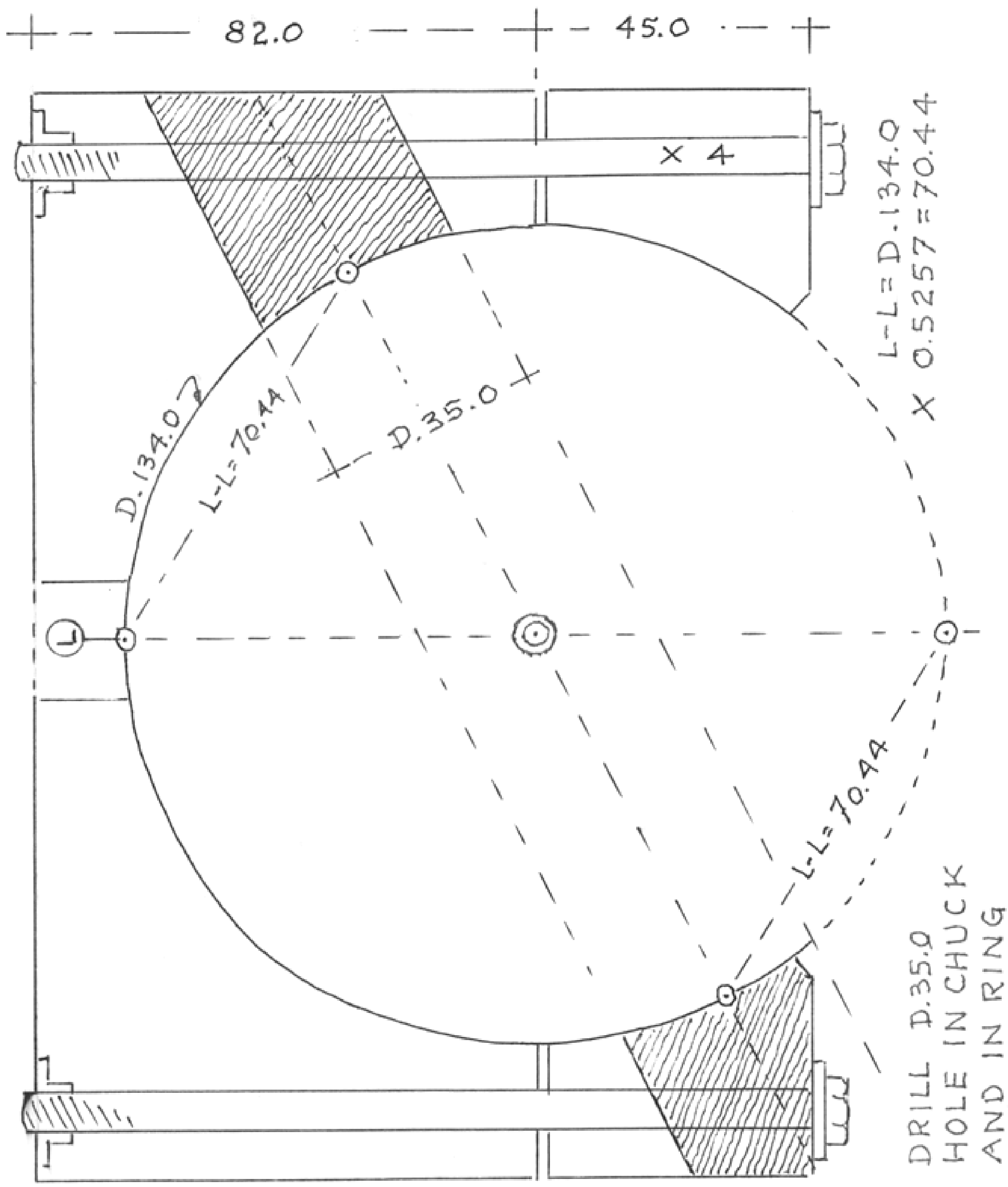


ITEM NO. 4

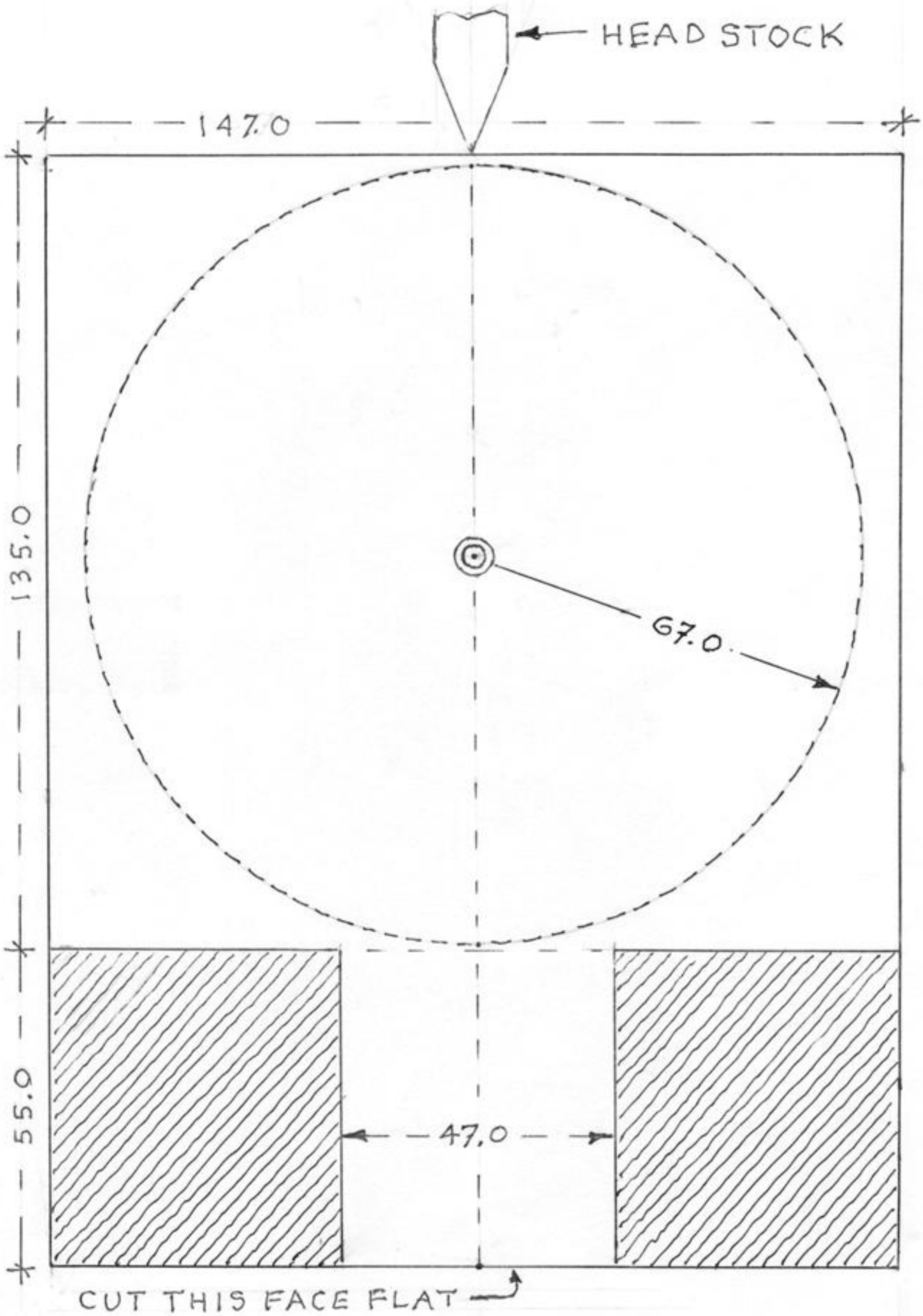
FOR DETAILS SEE "CONTENTS" SEMI-SPHERICAL CHUCK



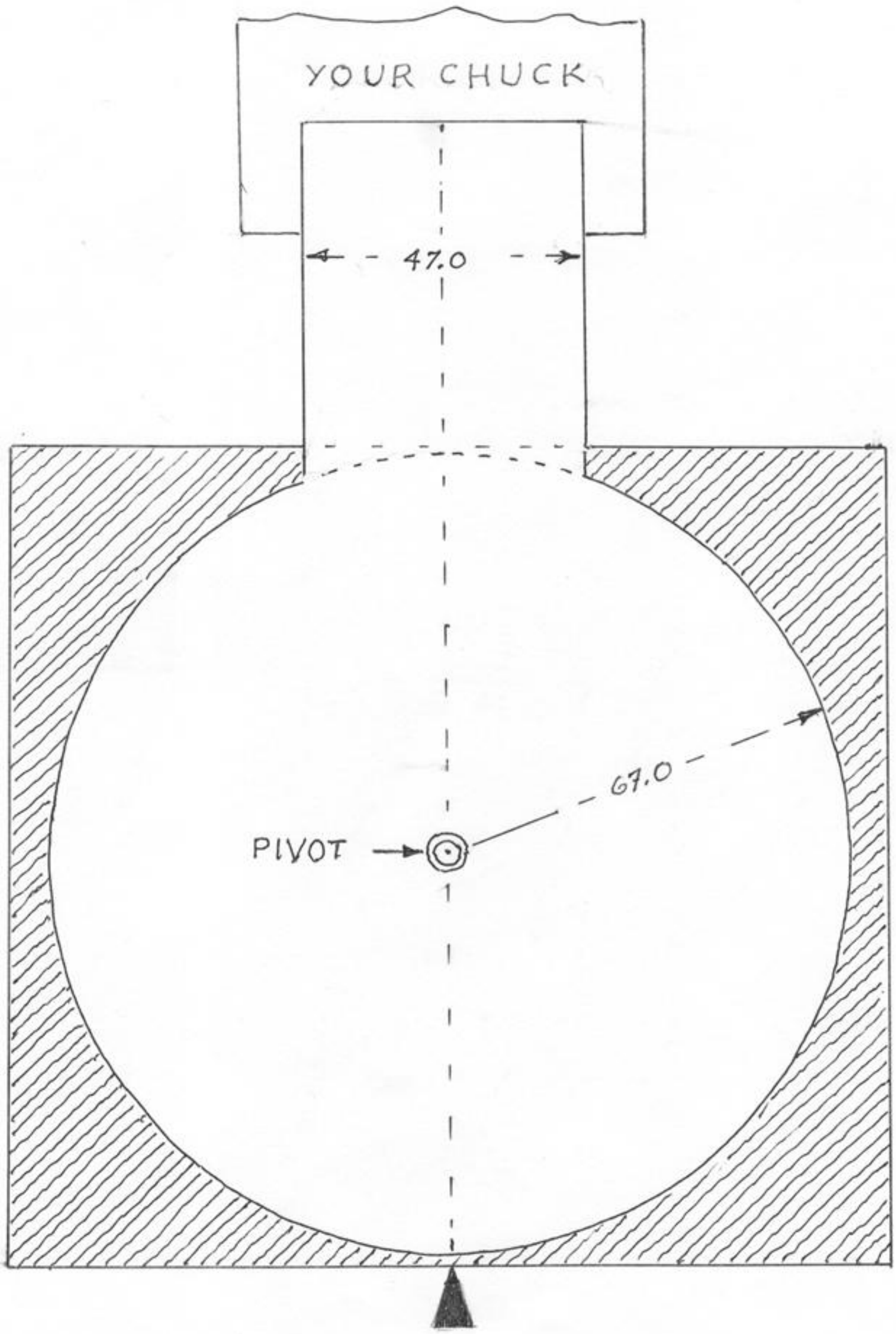
ITEM NO.5


82.0
45.0
X 4
L-L=D.134.0
X 0.5257=70.44
D.134.0
L-L=70.44
D.35.0
L
L-L=70.44
DRILL D.35.0
HOLE IN CHUCK
AND IN RING

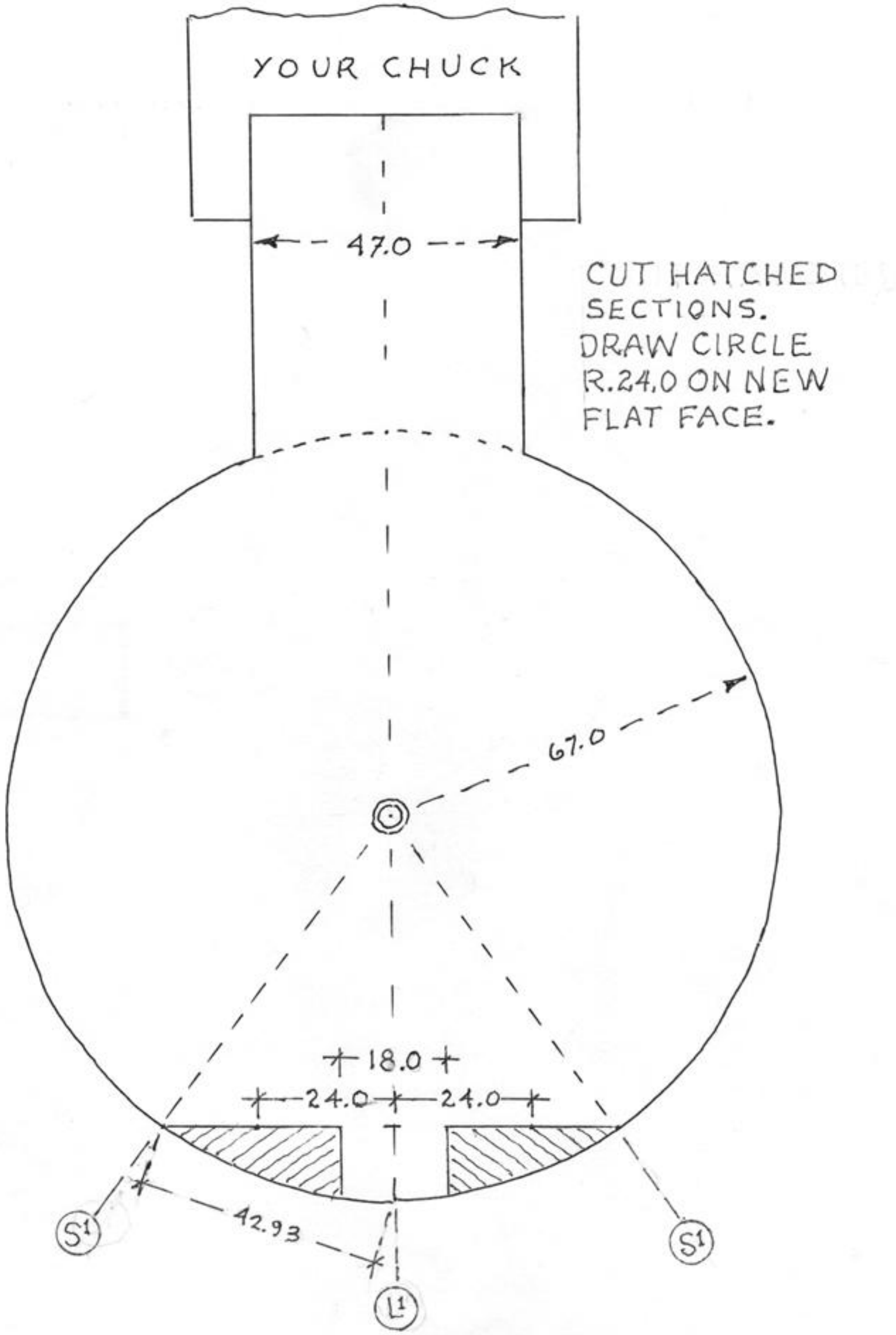
ITEM NO.6



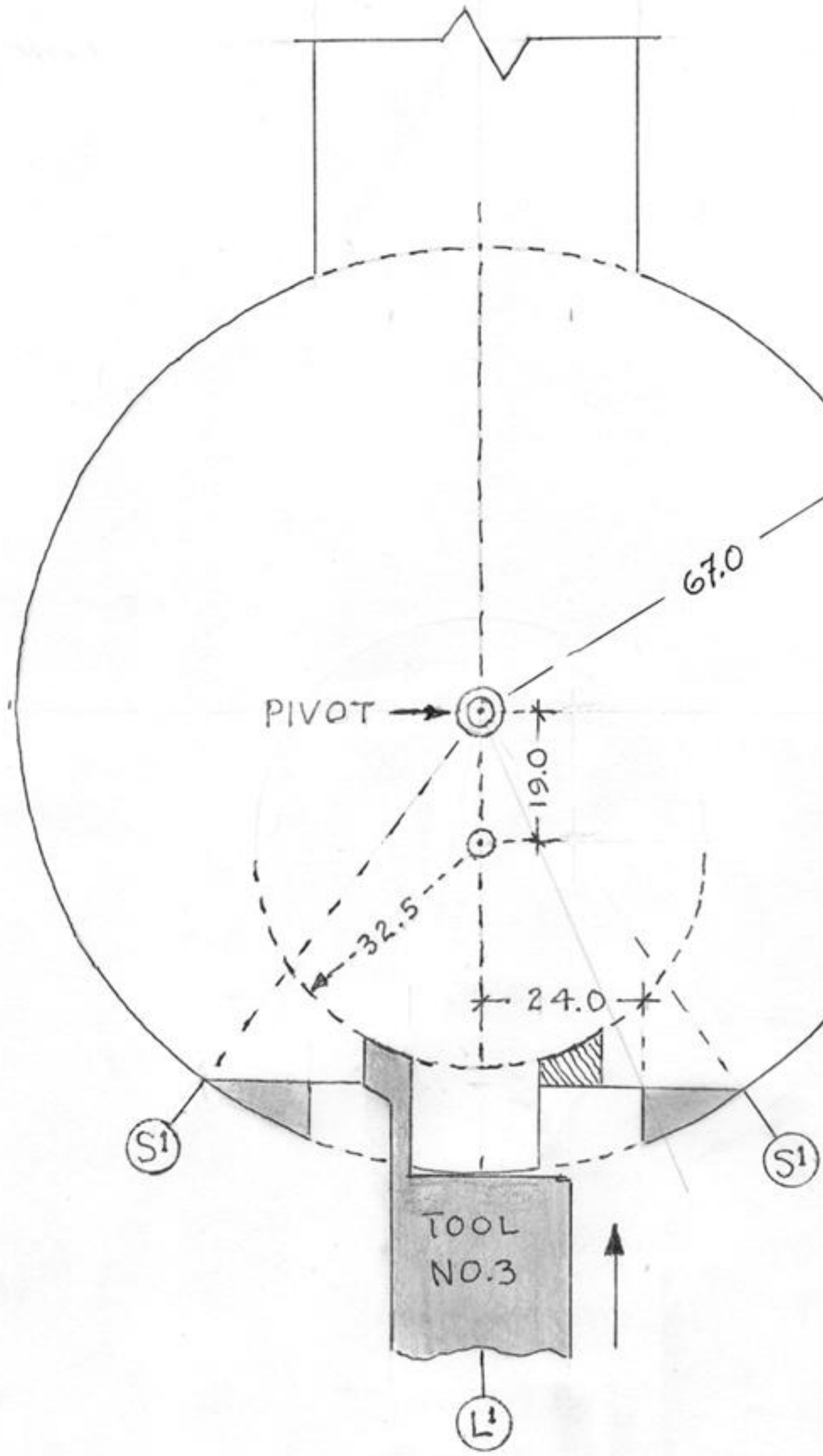
ITEM NO.7



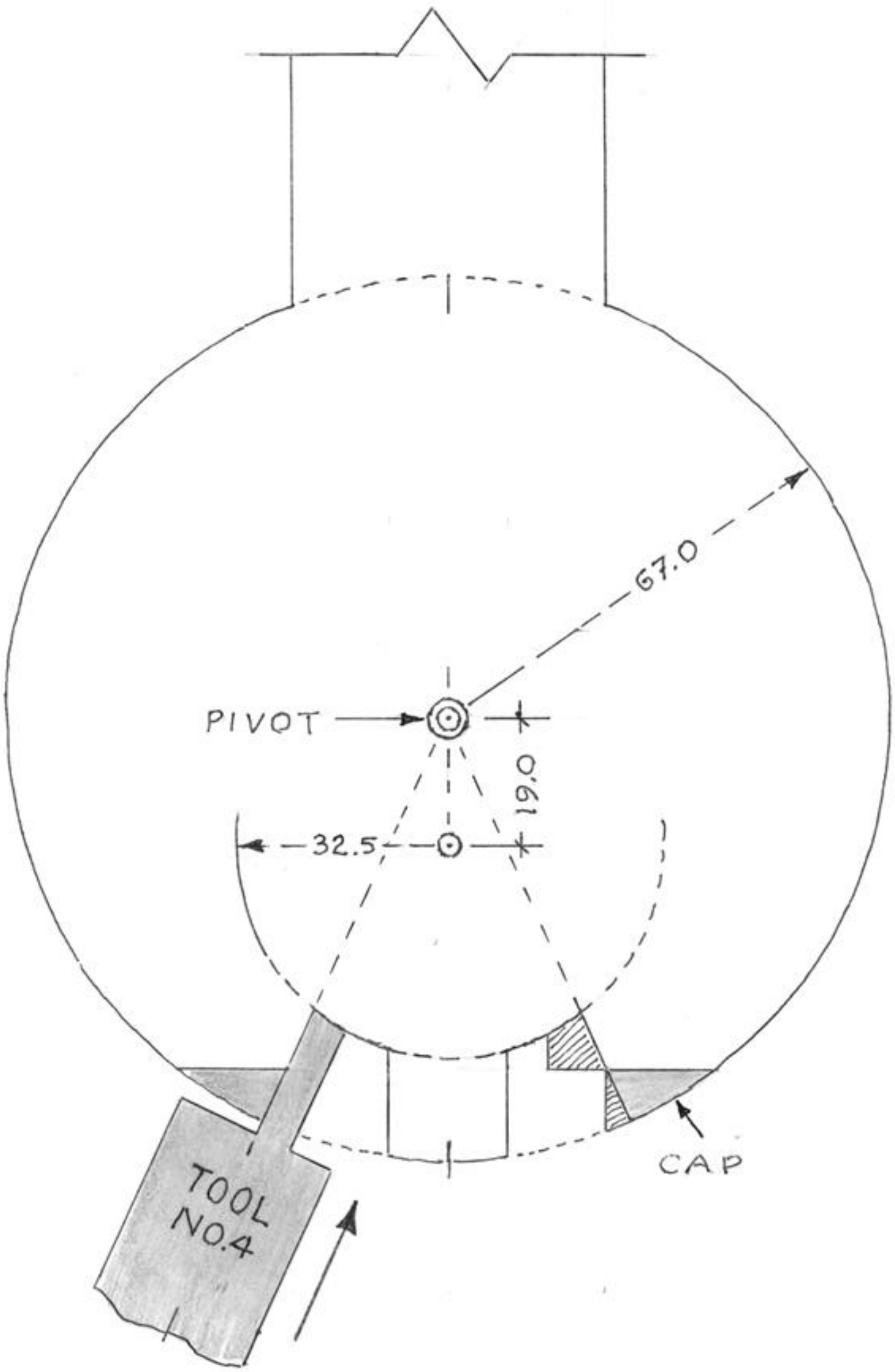
ITEM NO.8


YOUR CHUCK
47.0
CUT HATCHED SECTIONS.
DRAW CIRCLE R.24.0 ON NEW FLAT FACE.
67.0
18.0
24.0
24.0
42.93
S1
S1
L1

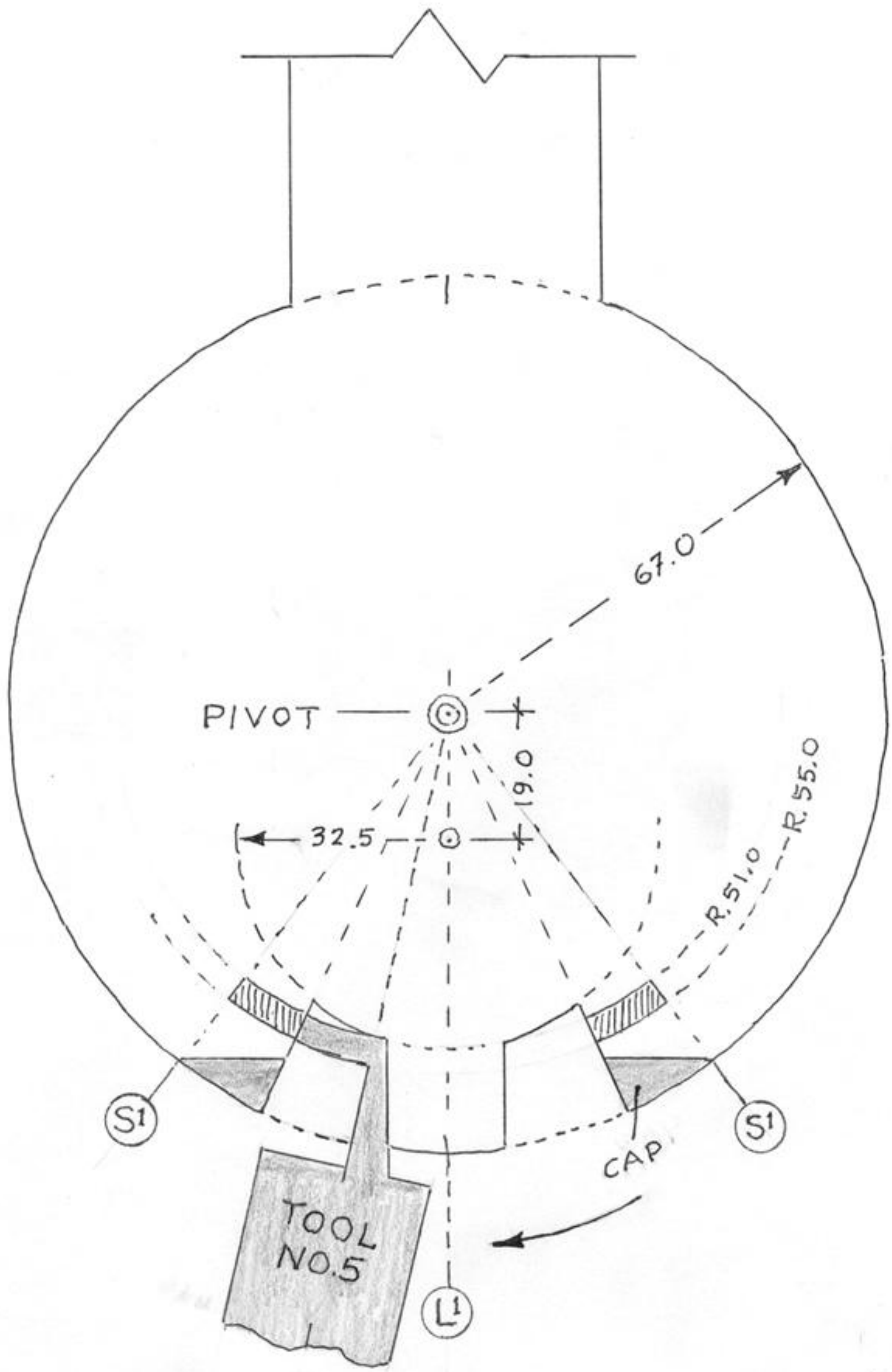
ITEM NO. 9



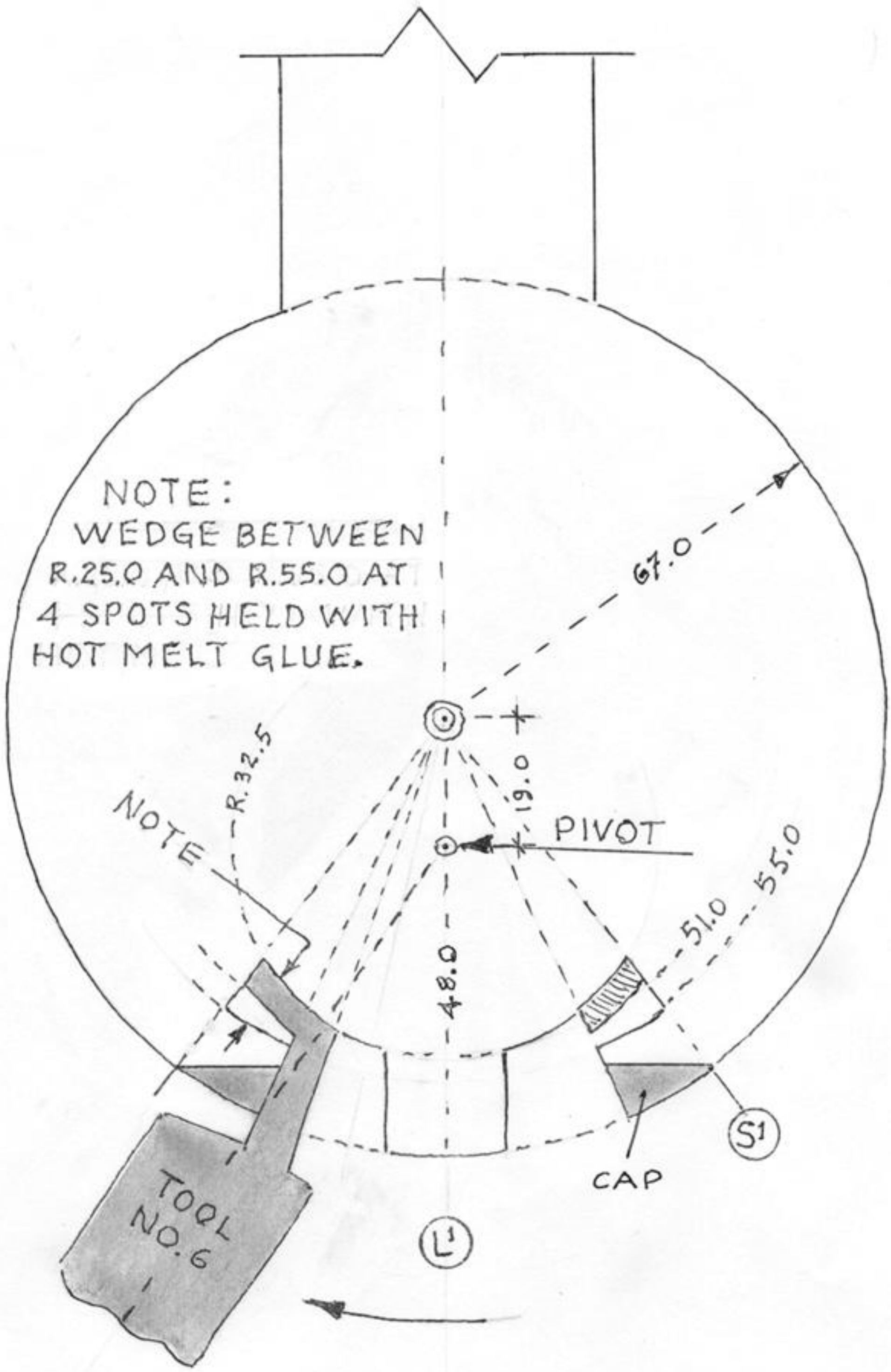
ITEM NO.10



ITEM NO. 11

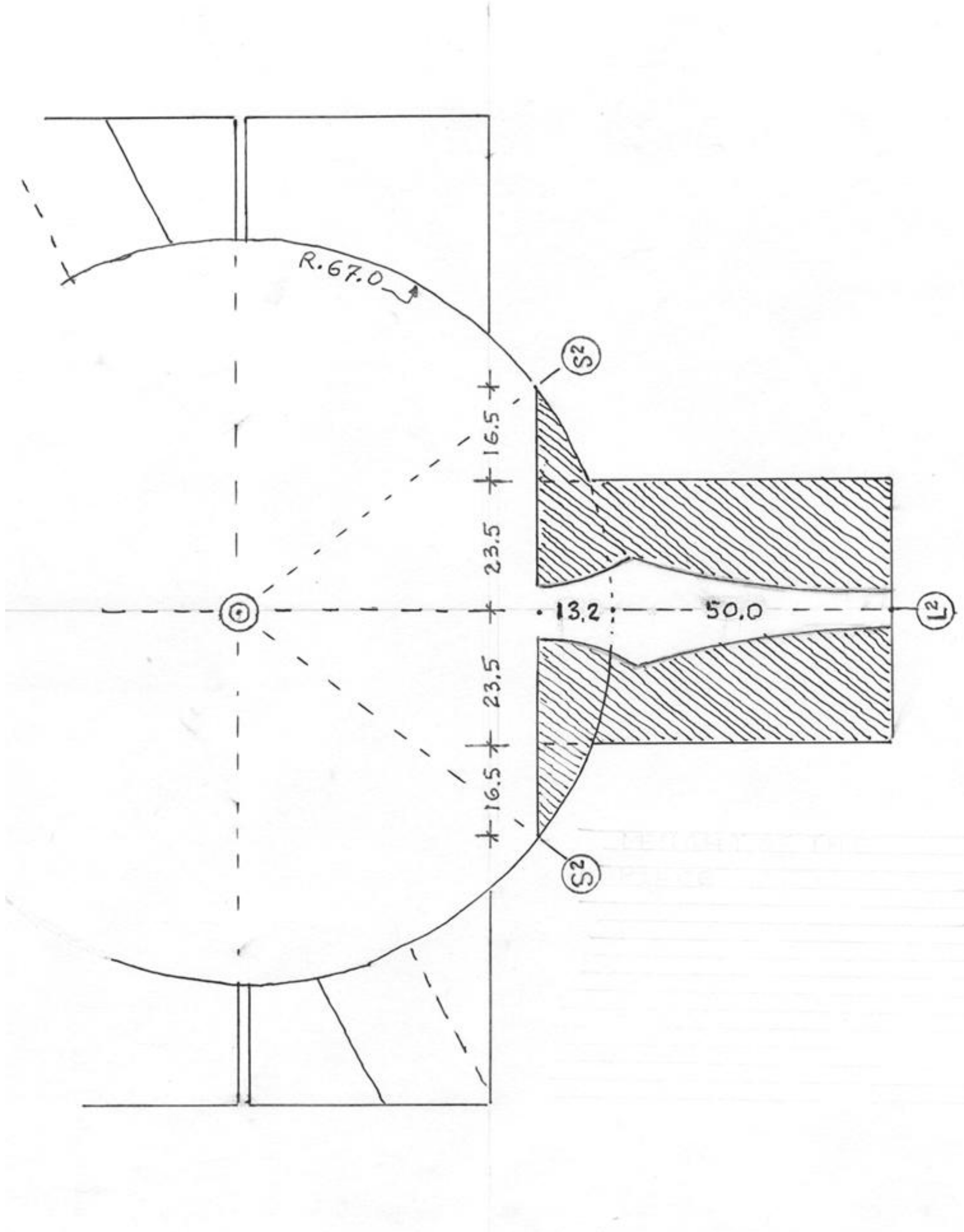


ITEM NO.12

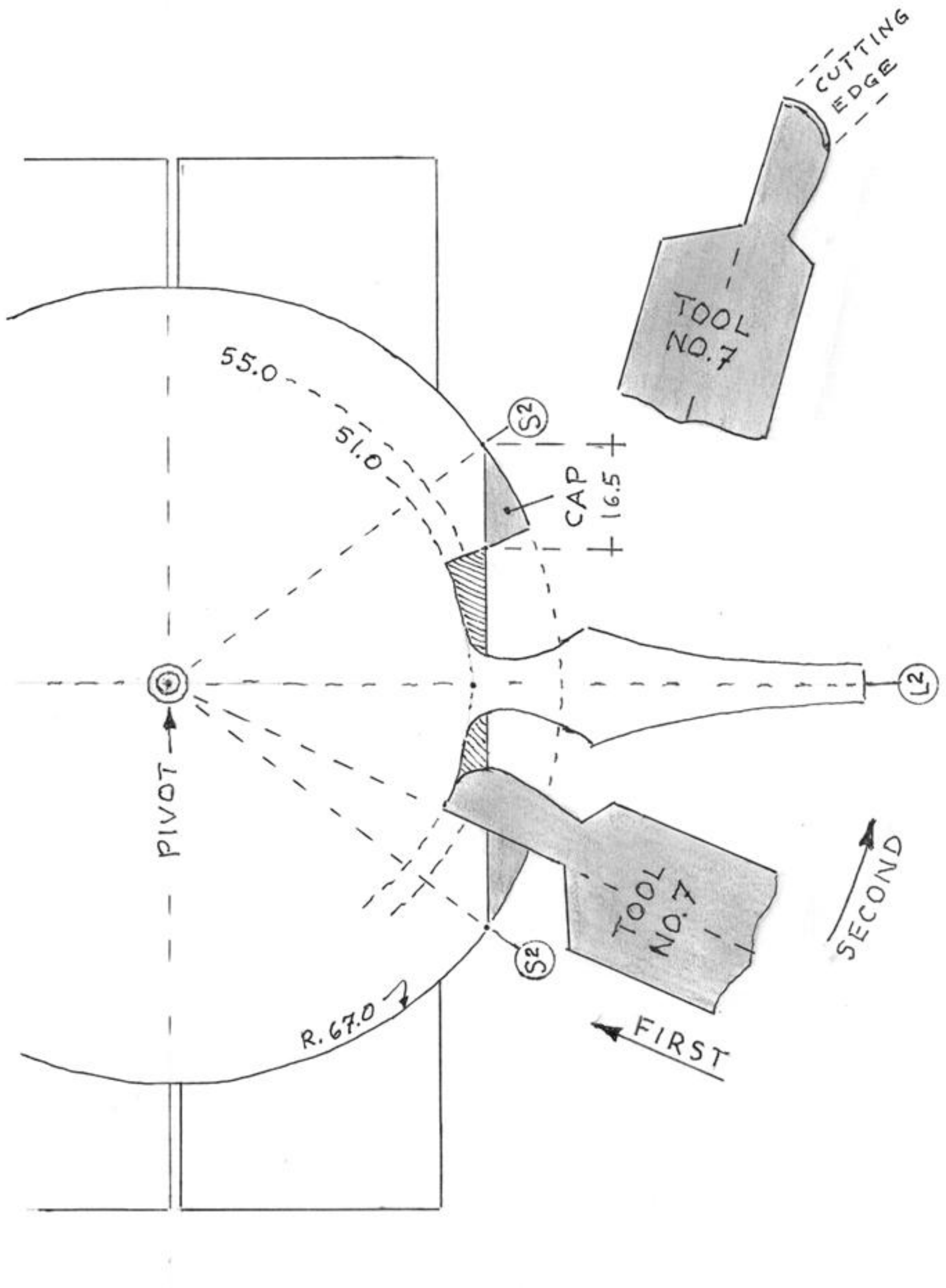


NOTE:
WEDGE BETWEEN
R.25.0 AND R.55.0 AT
4 SPOTS HELD WITH
HOT MELT GLUE.
67.0
R.32.5
NOTE
19.0
PIVOT
55.0
51.0
48.0
TOOL
NO.6
S1
CAP
L1

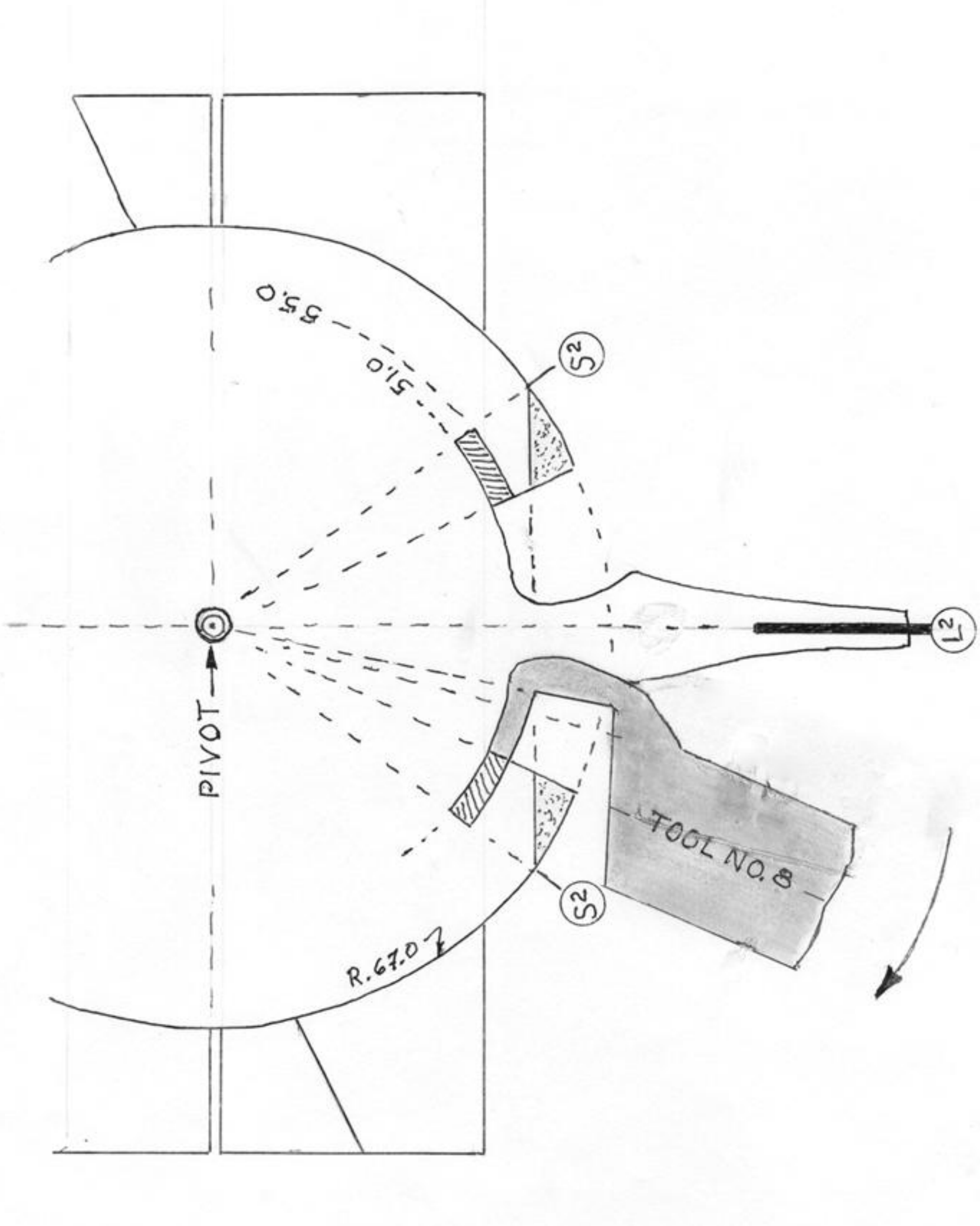
ITEM NO. 13



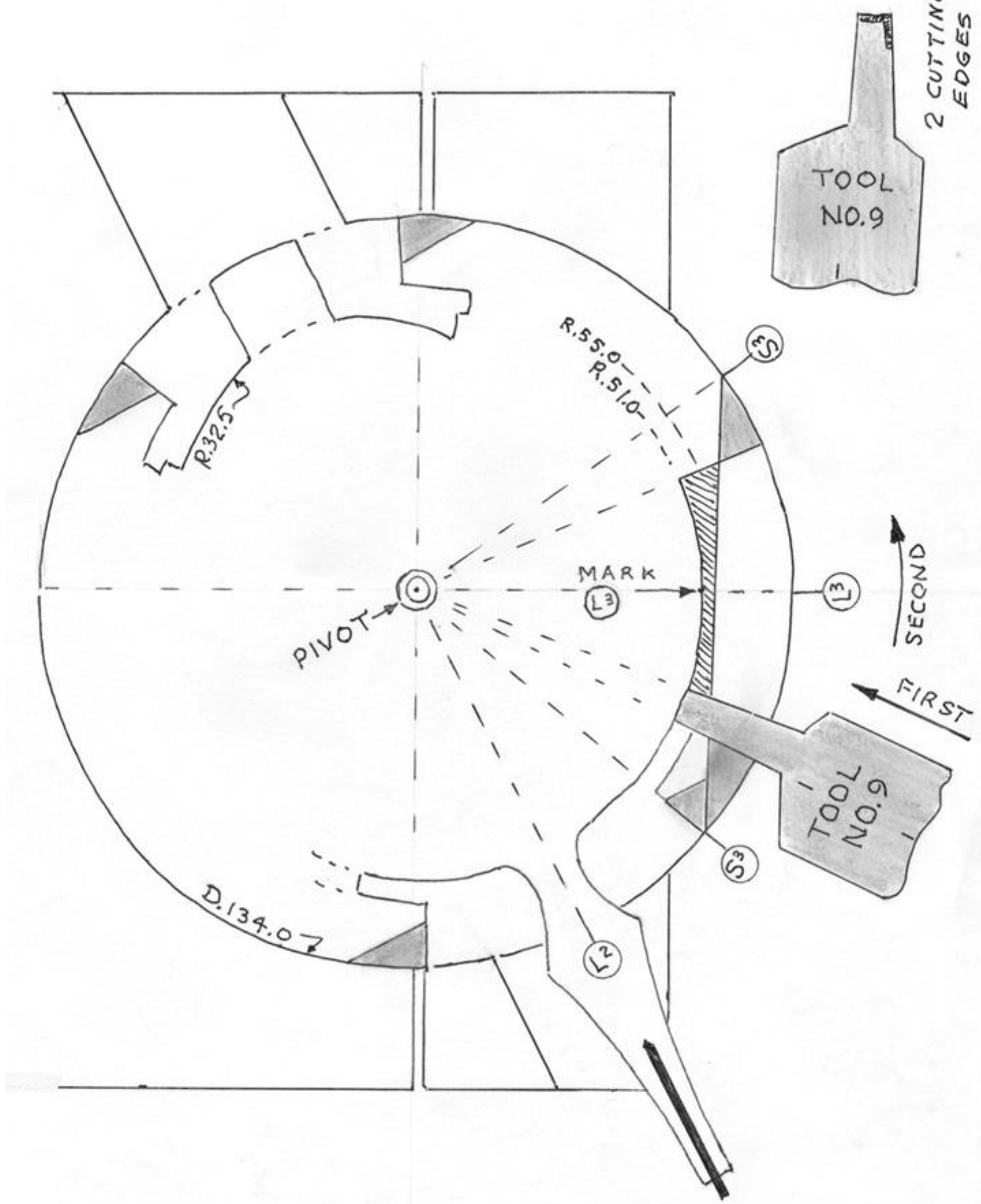
ITEM NO. 14


CUTTING EDGE
TOOL NO.7
55.0
51.0
S2
CAP
16.5
L2
PIVOT
TOOL NO.7
SECOND
S2
R. 67.0
FIRST

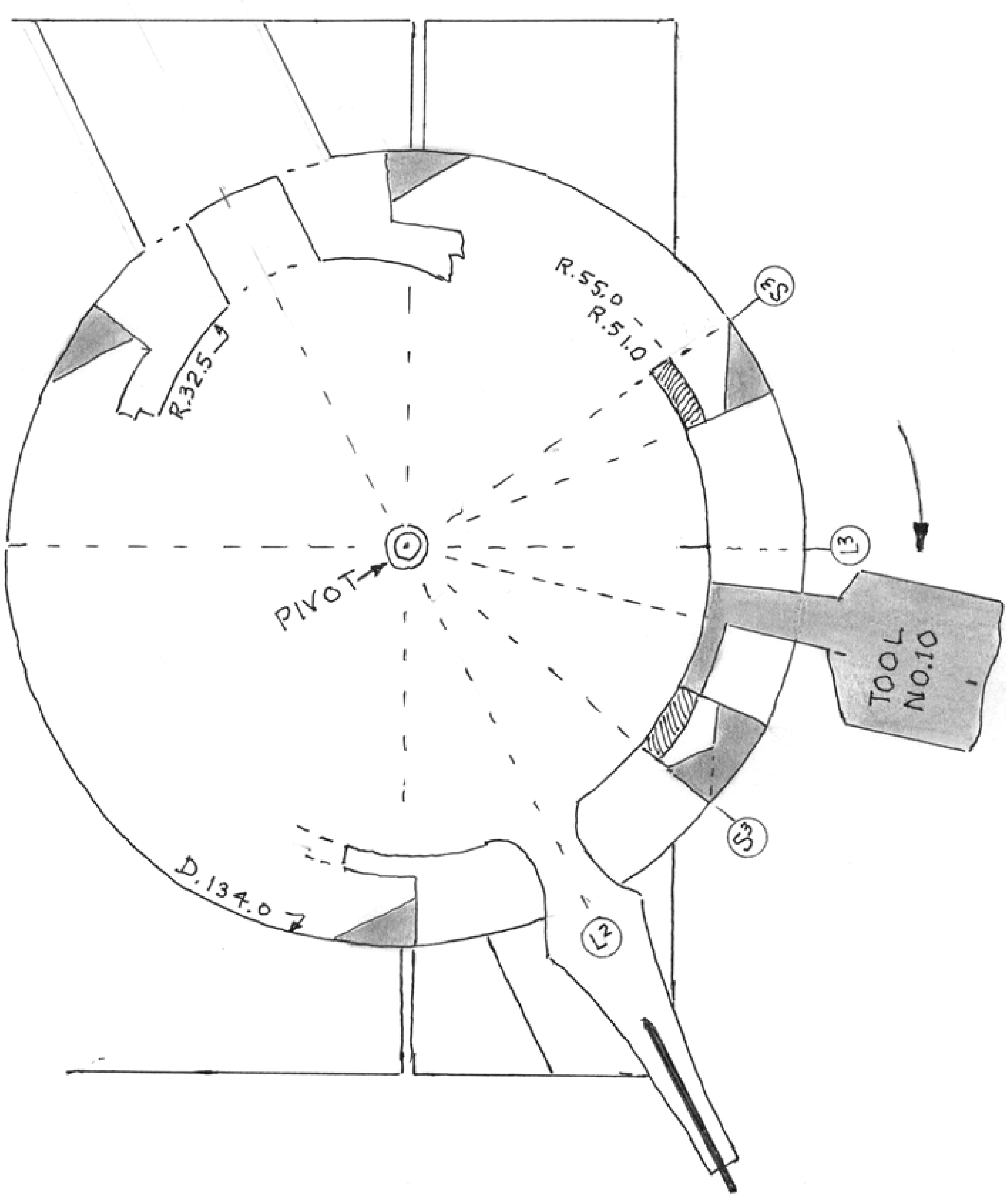
ITEM NO. 15



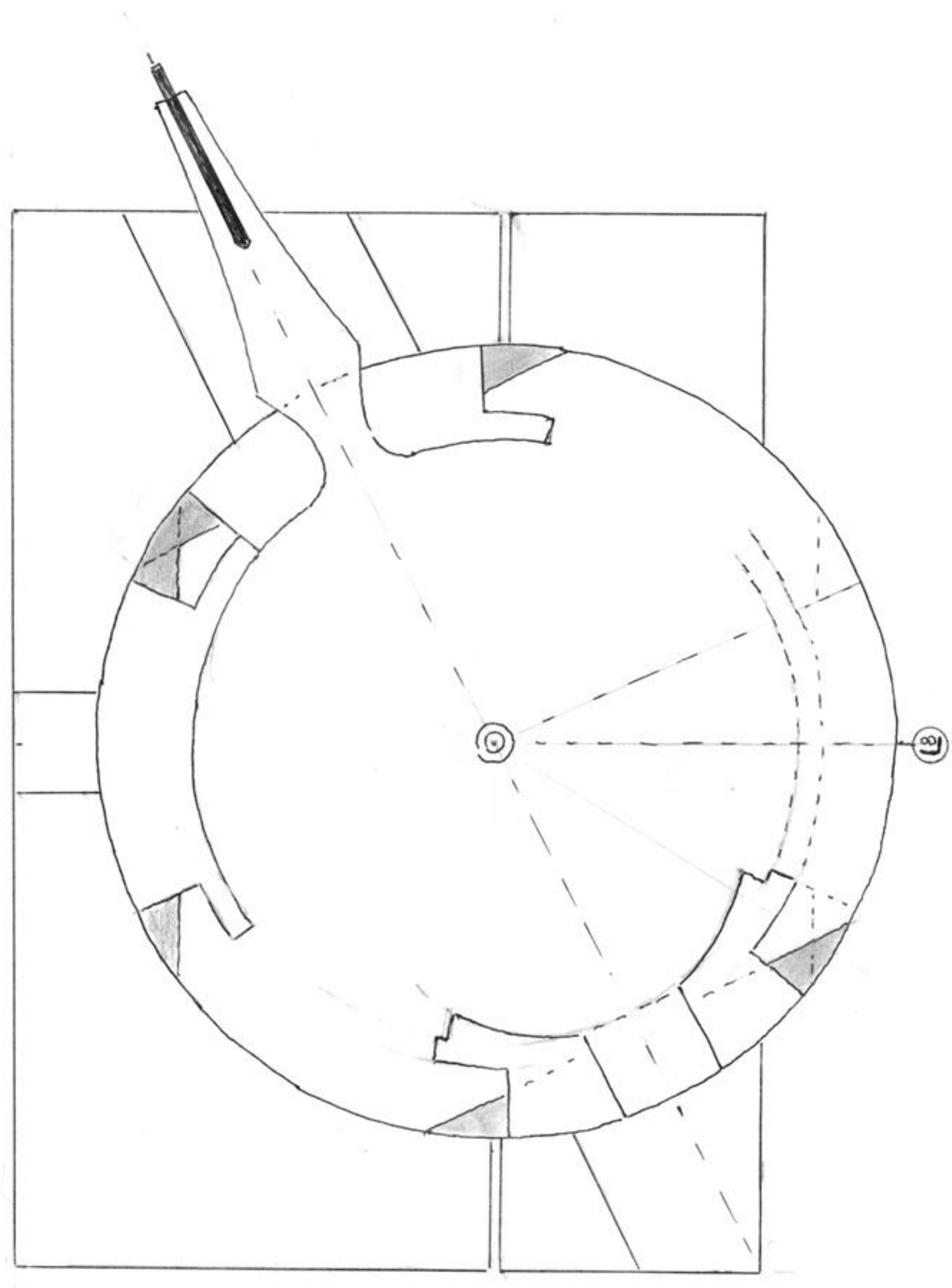
ITEM NO.16


2 CUTTING EDGES
TOOL NO.9
R.55.0
R.51.0
S3
R.32.5
MARK
L3
L3
PIVOT
SECOND
FIRST
TOOL NO.9
S3
D.134.0
L2

ITEM NO.17

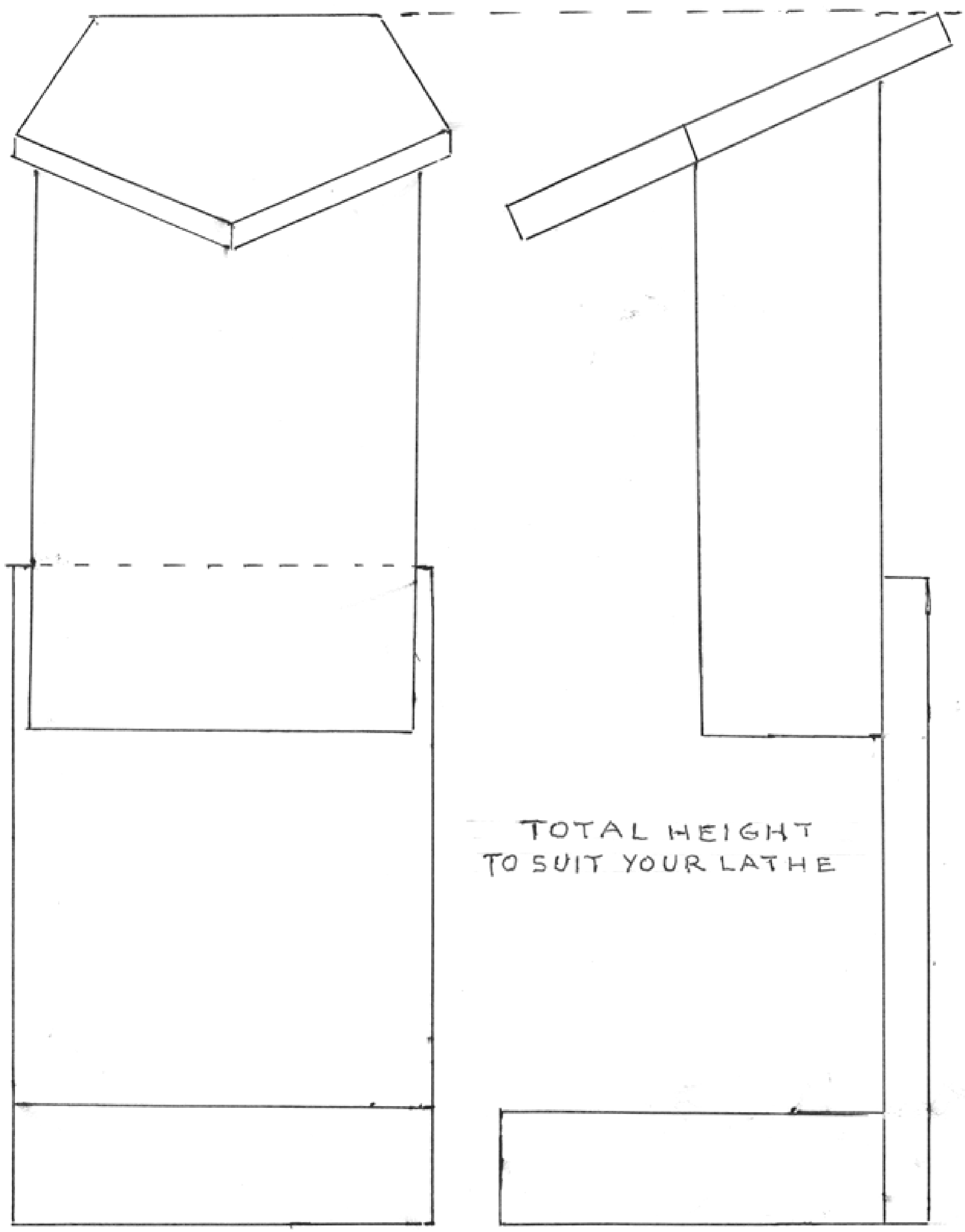


ITEM NO. 19



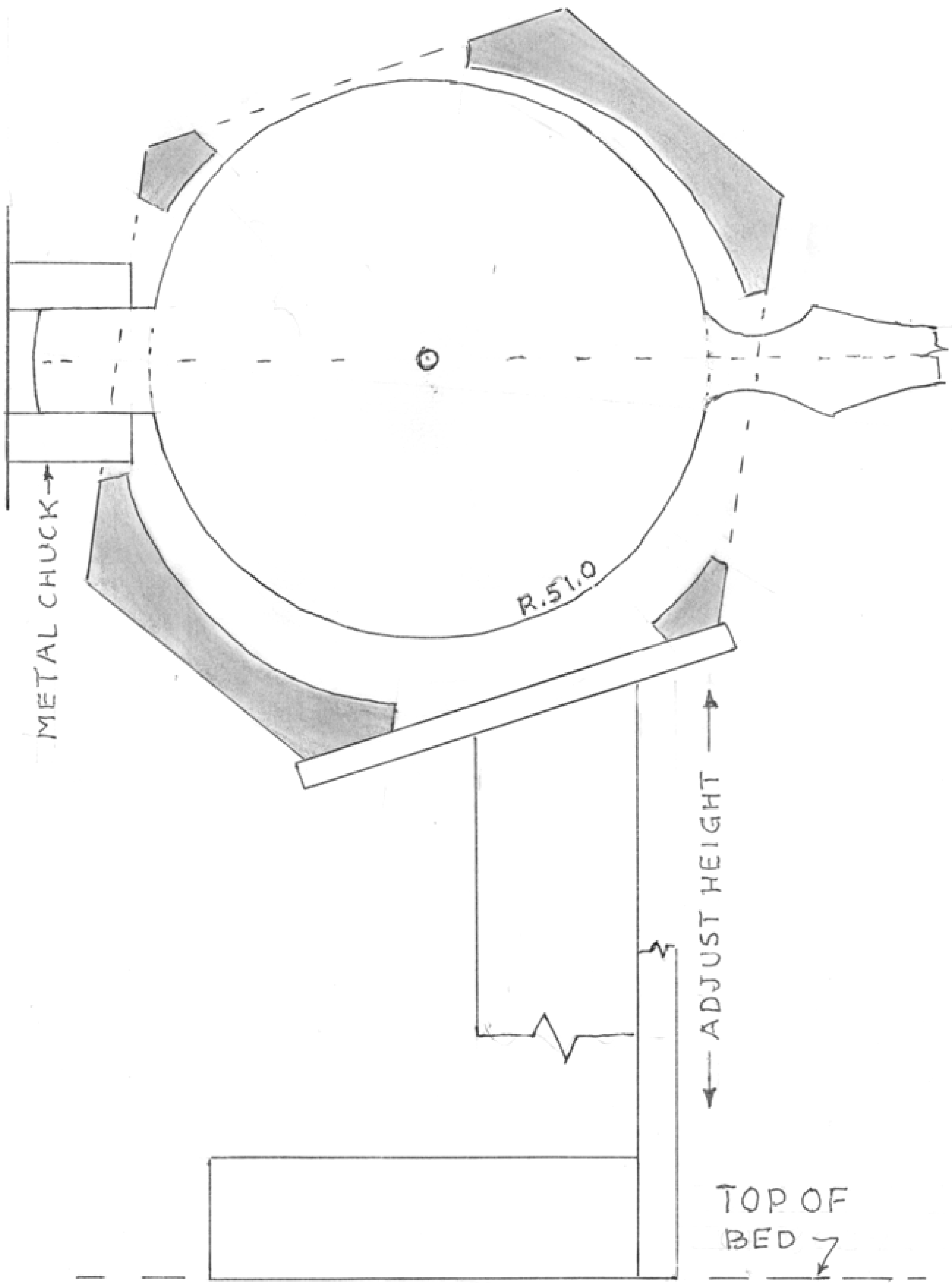
ITEM NO. 21

— SUPPORT —



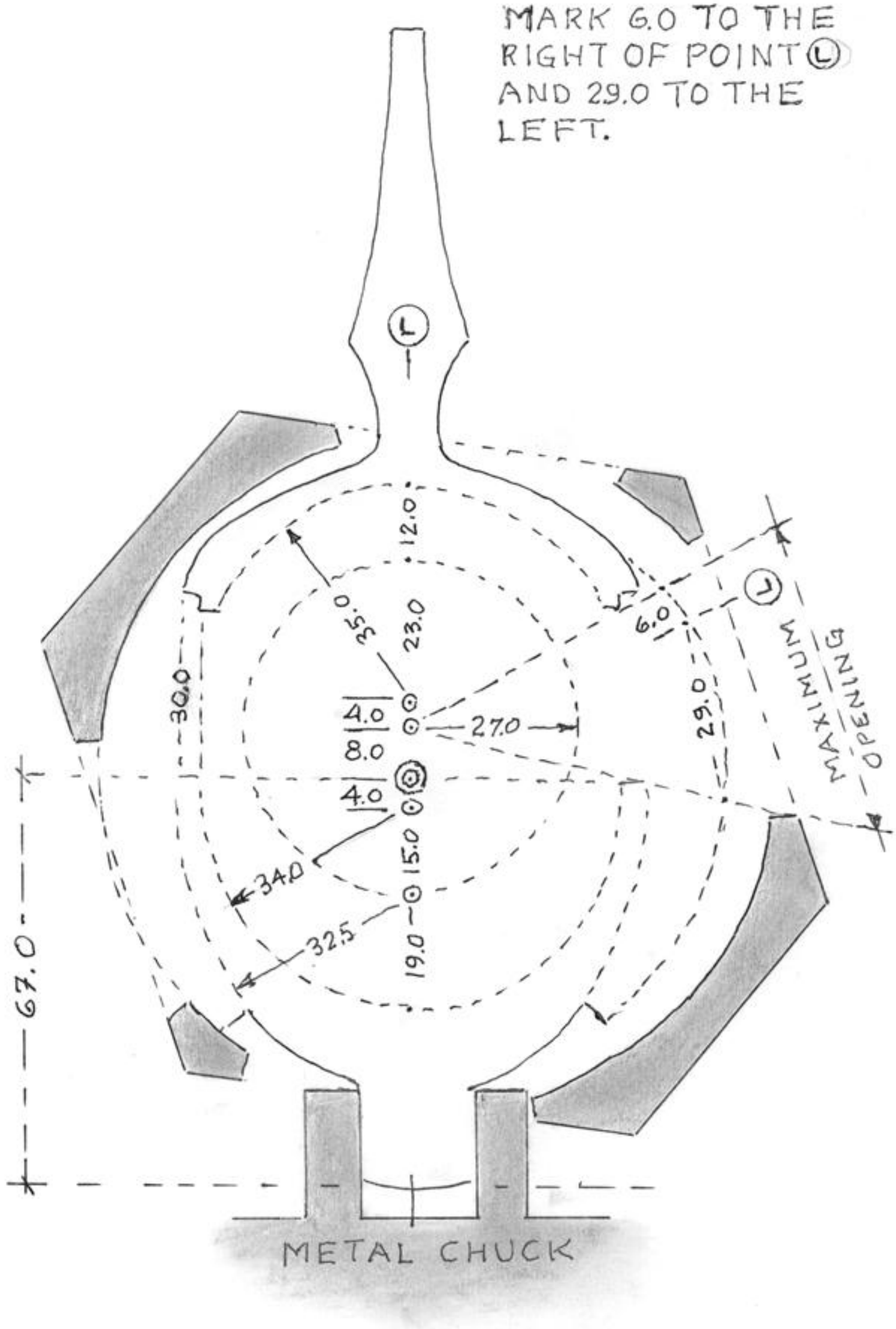
MOVE TO SUIT AND FIX IT TO LATHE BED

ITEM NO. 22

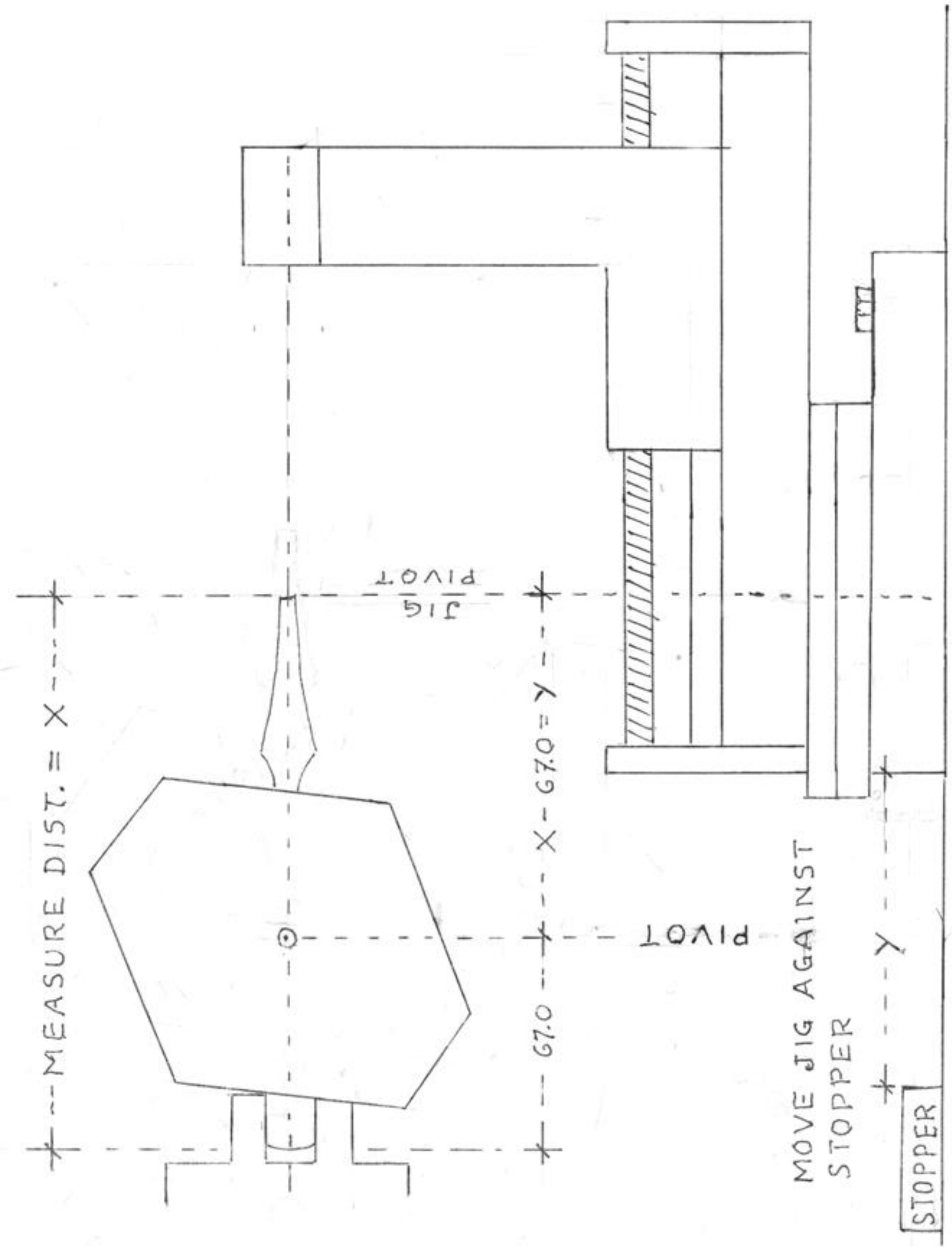


ITEM NO. 23

MARK 6.0 TO THE RIGHT OF POINT Ⓛ AND 29.0 TO THE LEFT.

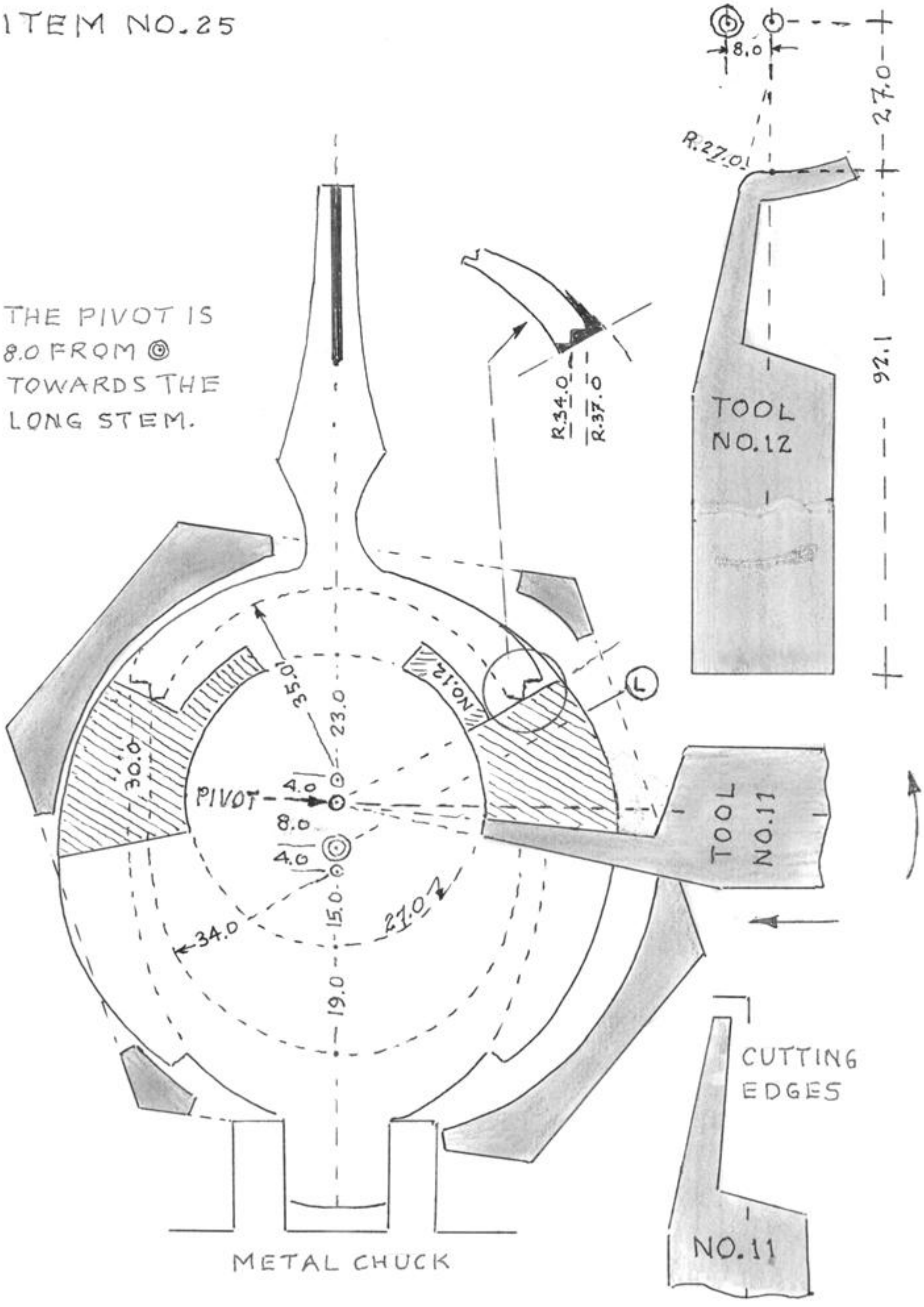


ITEM NO. 24

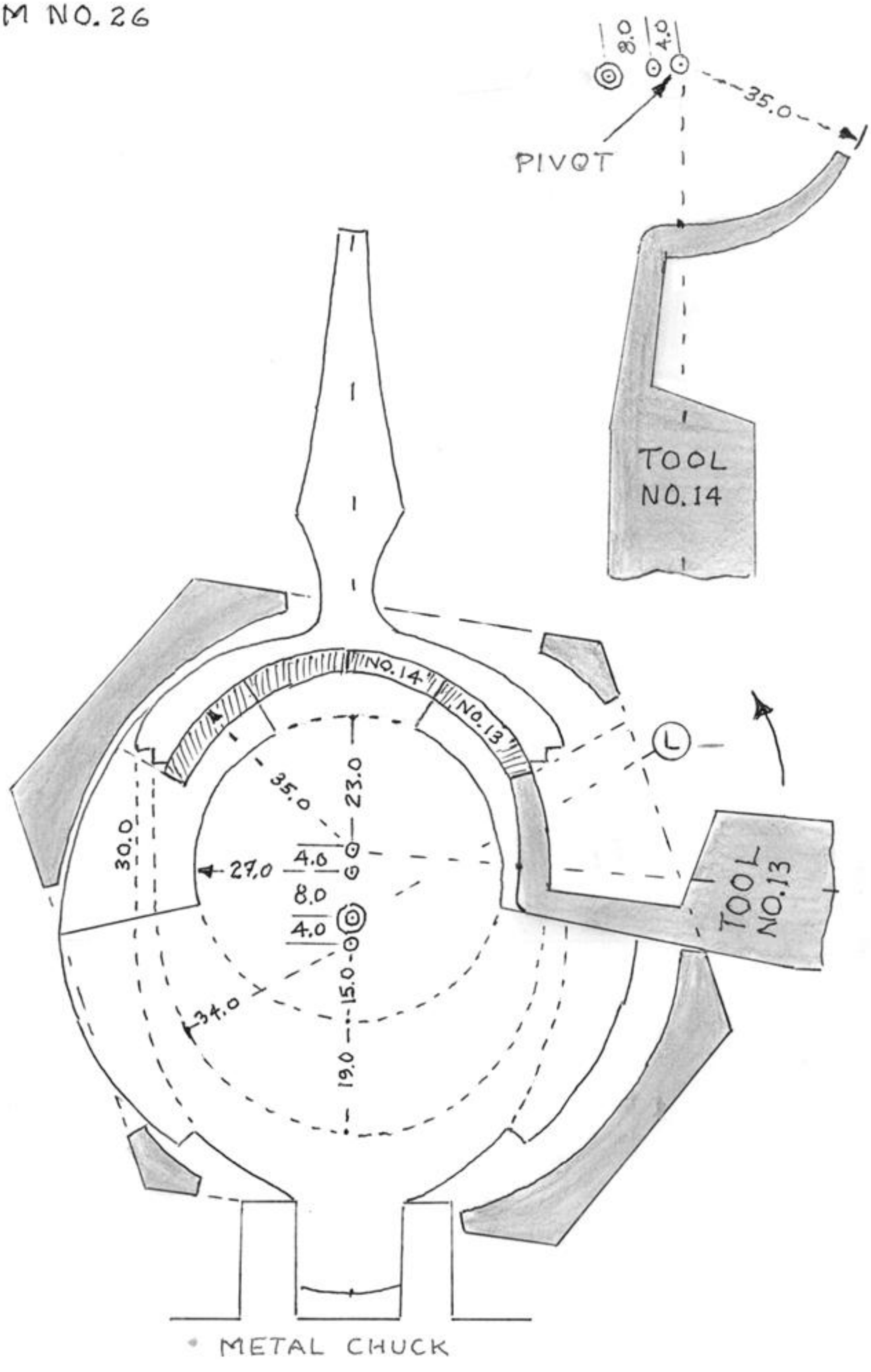


JIG PIVOT
MEASURE DIST. = X
X - 67.0 = Y
67.0
PIVOT
MOVE JIG AGAINST STOPPER
Y
STOPPER

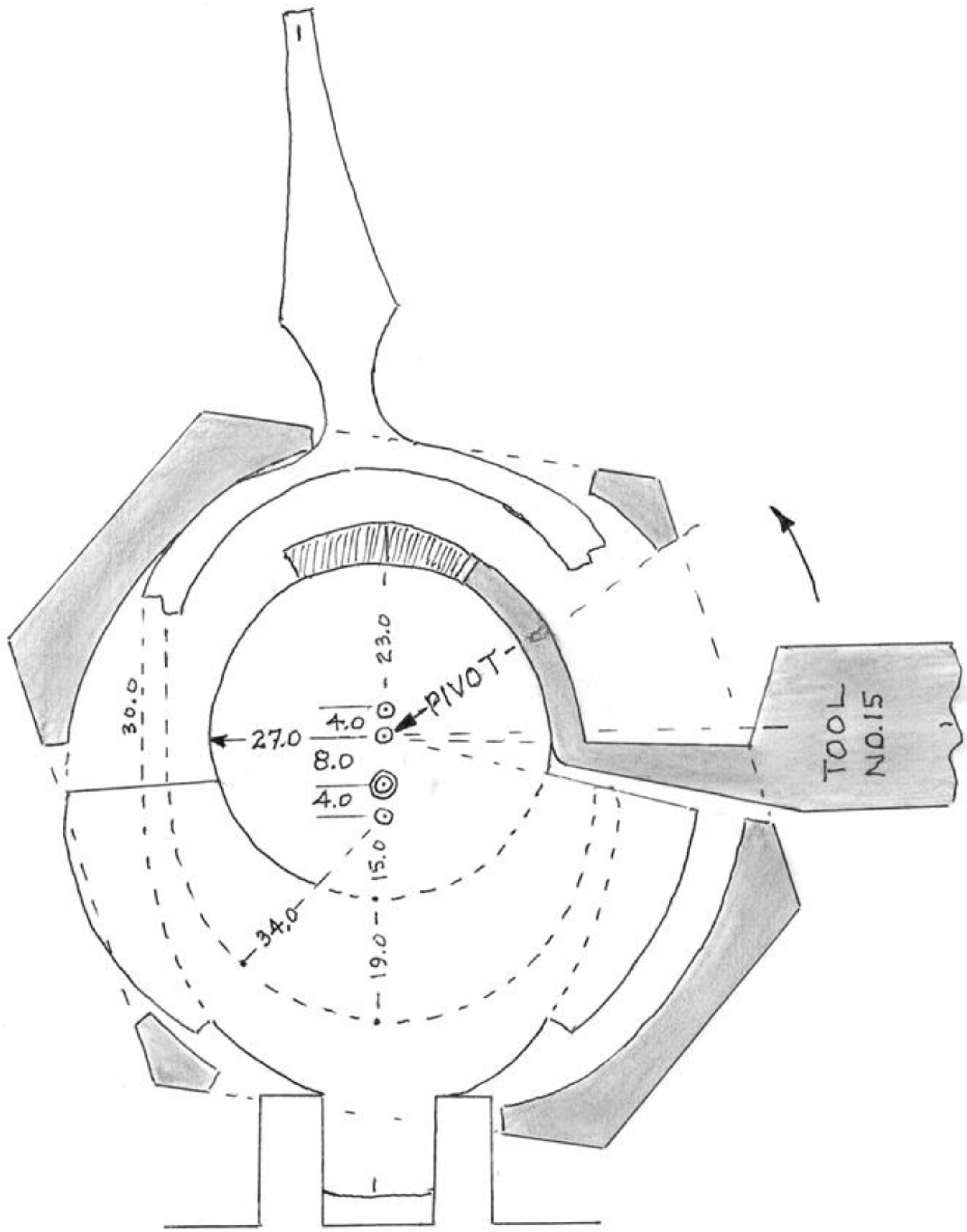
ITEM NO.25


THE PIVOT IS
8.0 FROM ◎
TOWARDS THE
LONG STEM.
8.0
27.0
R.27.0
92.1
TOOL
NO.12
R.34.0
R.37.0
L
35.0
23.0
30.0
NO.12
4.0
PIVOT
8.0
4.0
TOOL
NO.11
15.0
27.0
34.0
19.0
CUTTING
EDGES
NO.11
METAL CHUCK

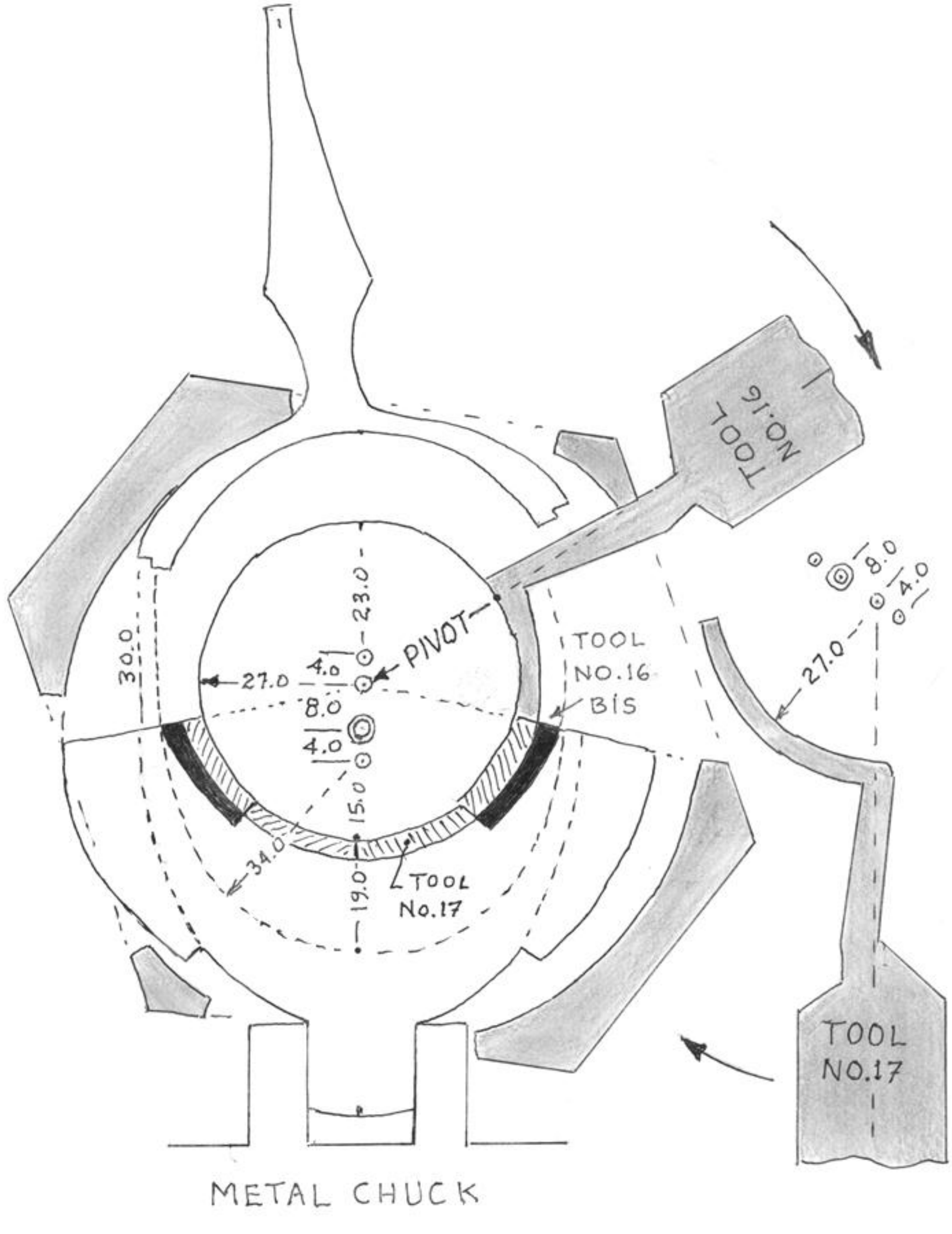
ITEM NO. 26


8.0
4.0
35.0
PIVOT
TOOL NO.14
NO.14
NO.13
L
35.0
23.0
30.0
27.0
4.0
8.0
4.0
15.0
34.0
19.0
TOOL NO.13
METAL CHUCK

ITEM NO. 27

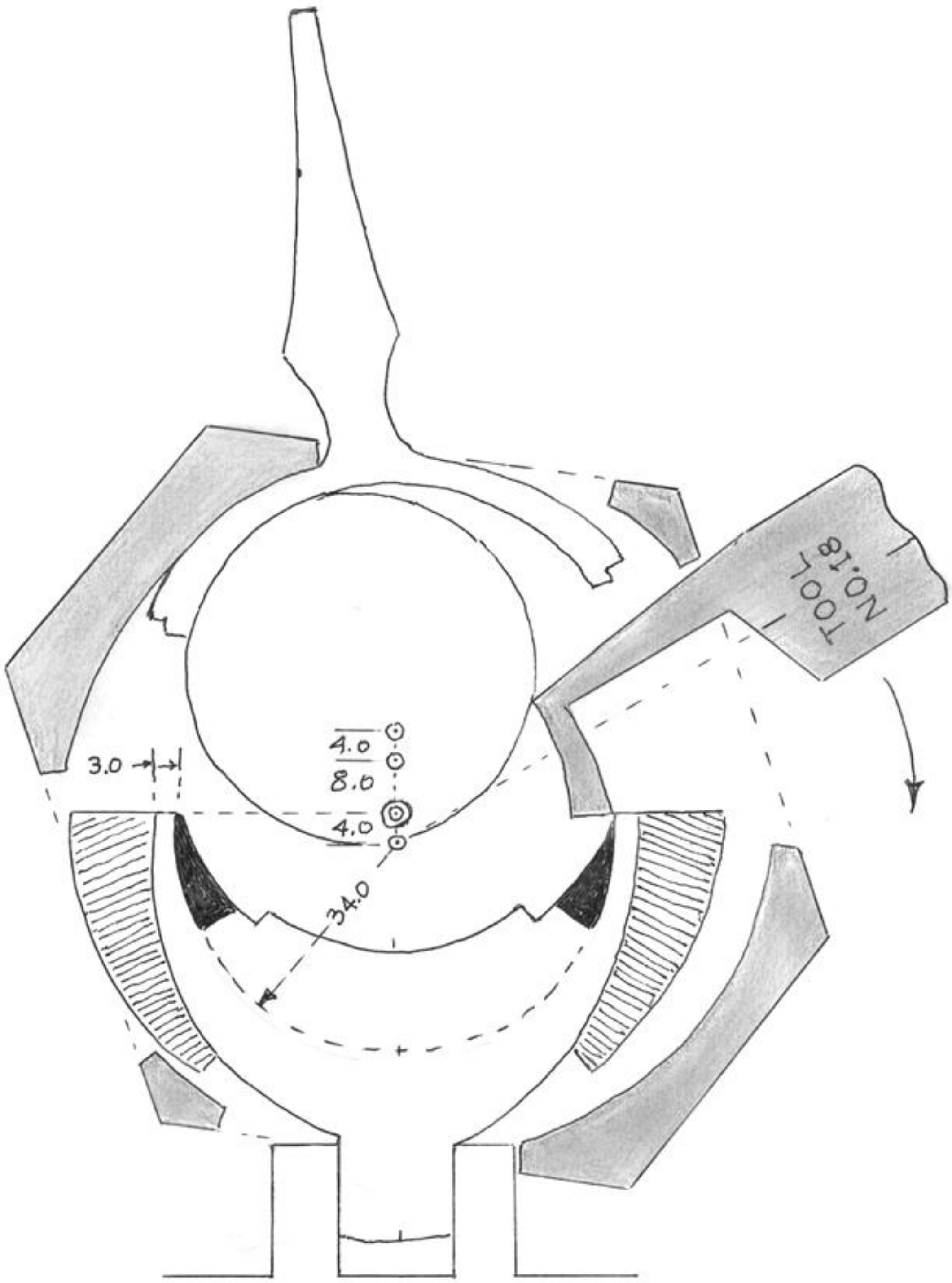


ITEM NO.28



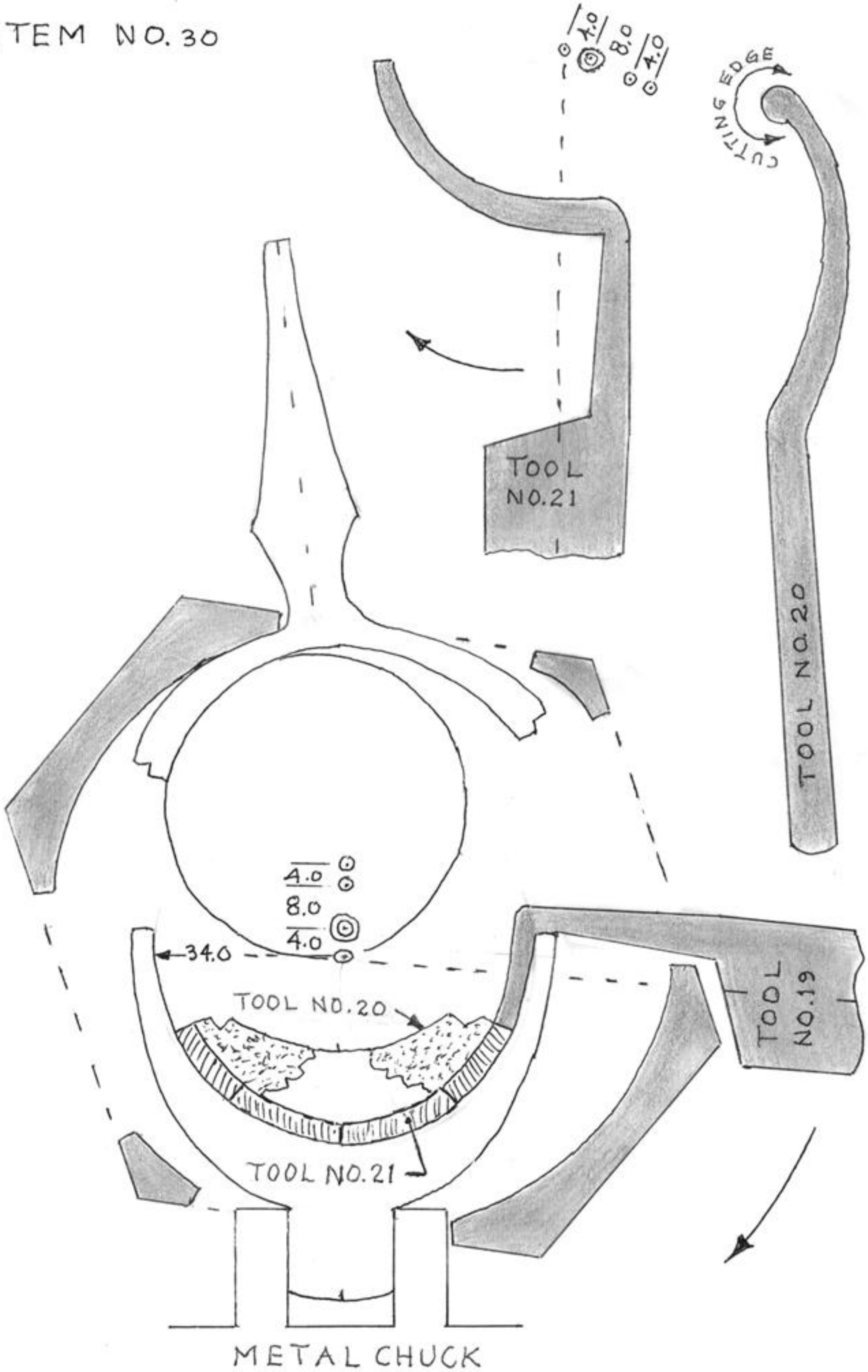
METAL CHUCK

ITEM NO.29



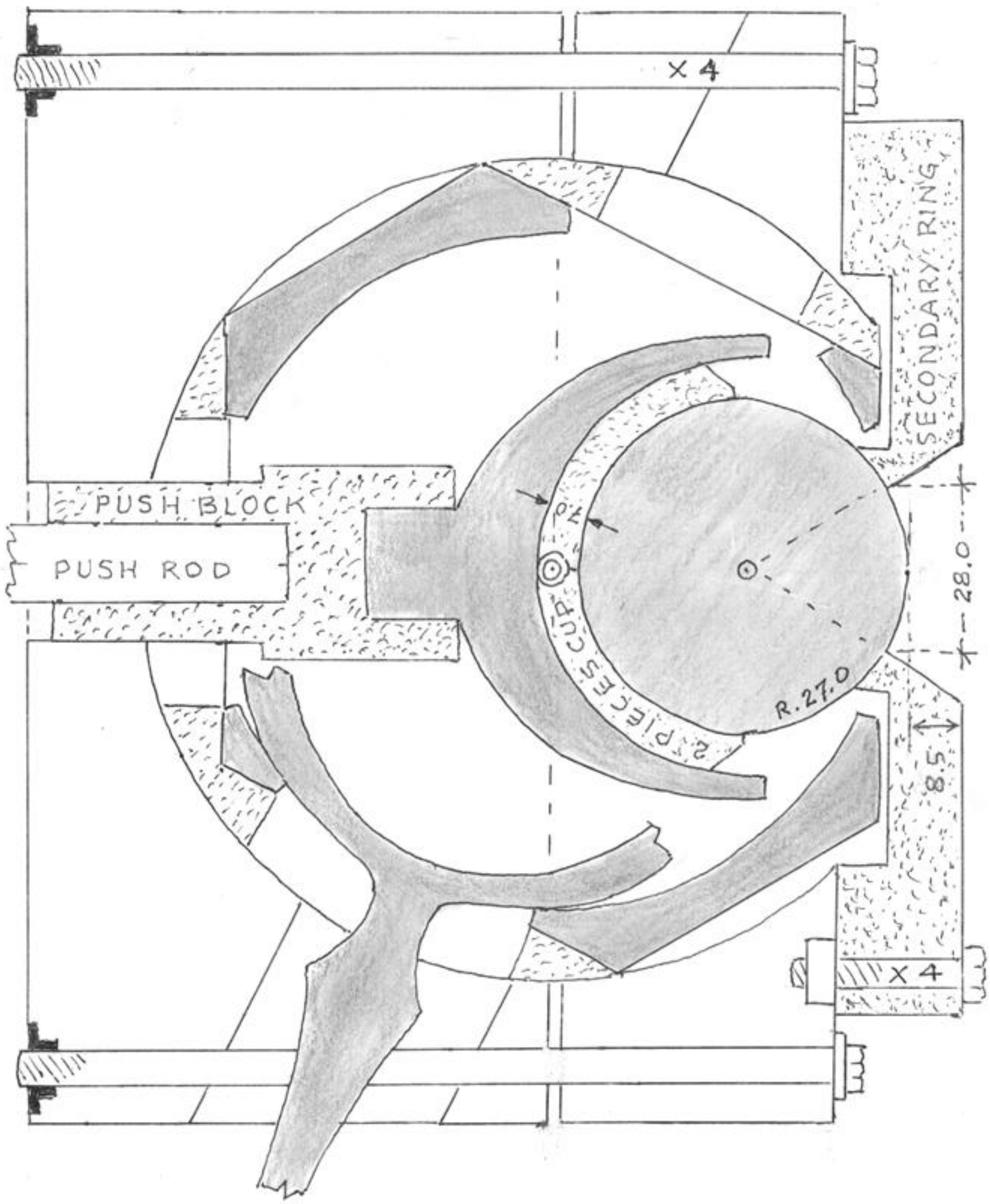
METAL CHUCK

ITEM NO. 30


4.0
8.0
4.0
CUTTING EDGE
TOOL
NO.21
TOOL NO.20
4.0
8.0
4.0
34.0
TOOL NO.20
TOOL NO.21
TOOL
NO.19
METAL CHUCK

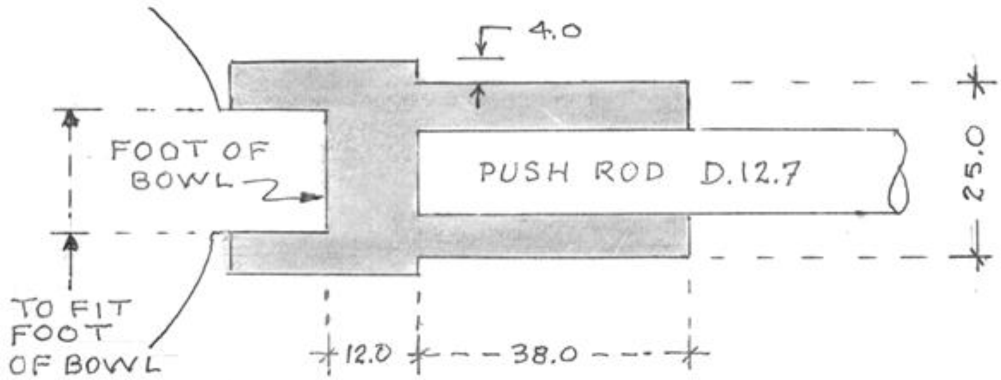
ITEM NO.31

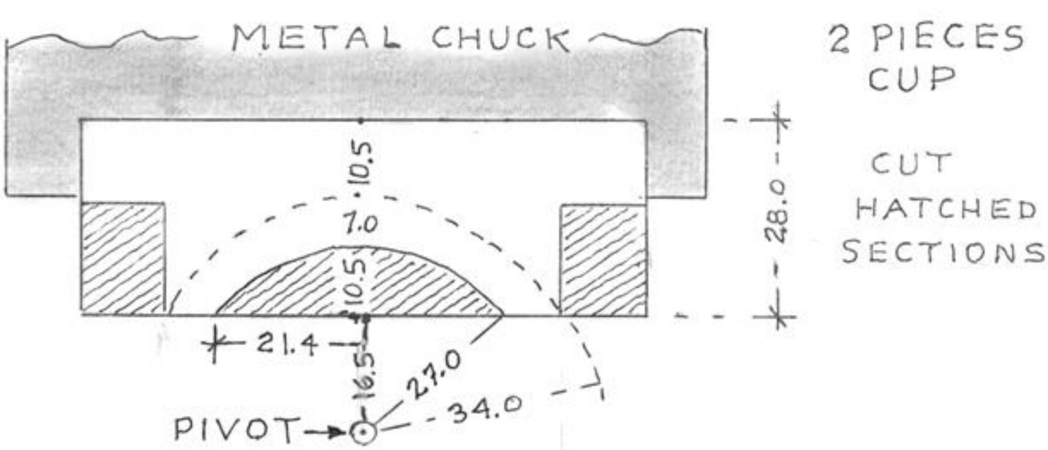
GENERAL SET UP TO TURN
INSIDE OF D.54.0 SPHERE

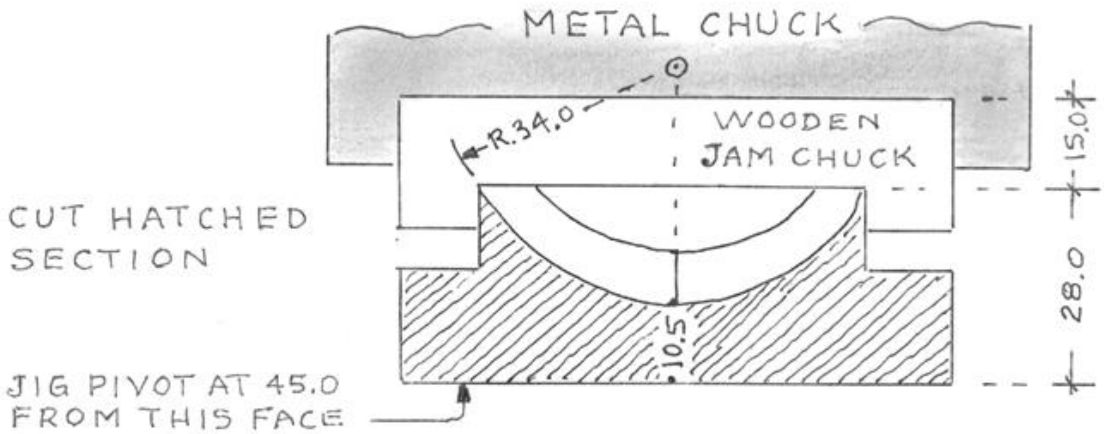


ITEM NO.32

PUSH BLOC

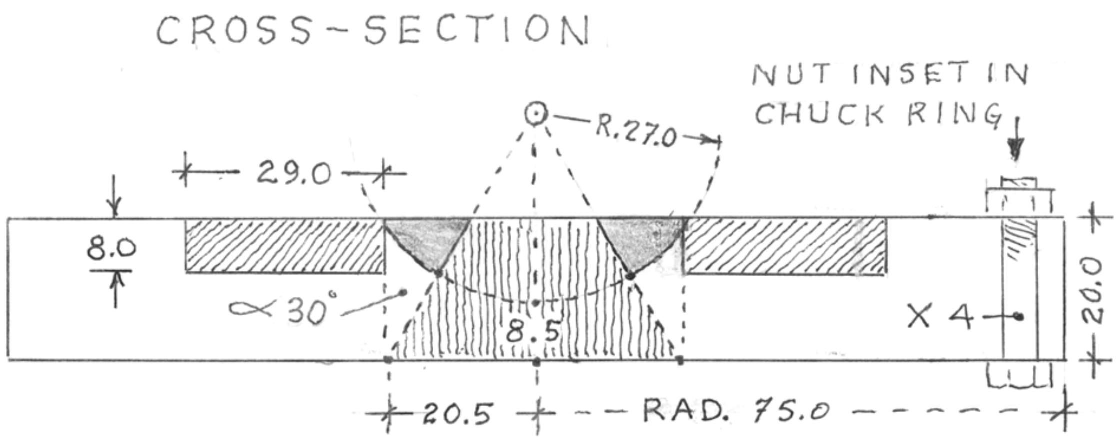






ITEM NO.33

SECONDARY CHUCK RING



A- From the back side, cut the groove 29.0 wide by 8.0 deep

B- Drill 4 holes for bolts

C- On the chuck with its ring, center secondary ring, mark location of the 4 bolts, drill and set (glue) 4 nuts, identify one bolt on both rings

D- Set secondary ring and mark center

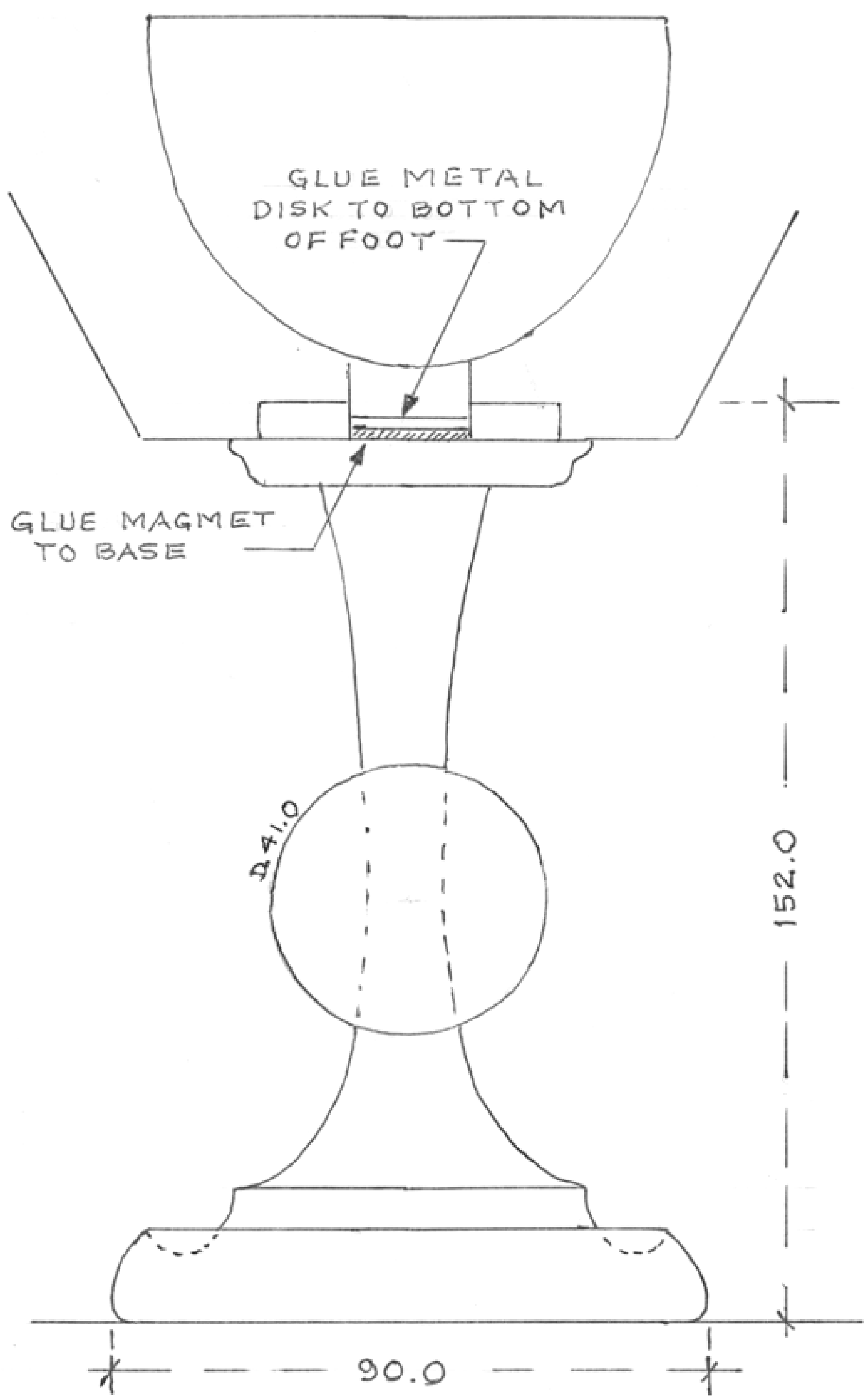
E- Set jig pivot 35.5 from face of second ring if thickness of secondary ring is 20.0, if not adjust

F- With tool N° 23 cut middle section at dotted line through second ring

G- With tool N°25 cut R.27

ITEM NO. 40

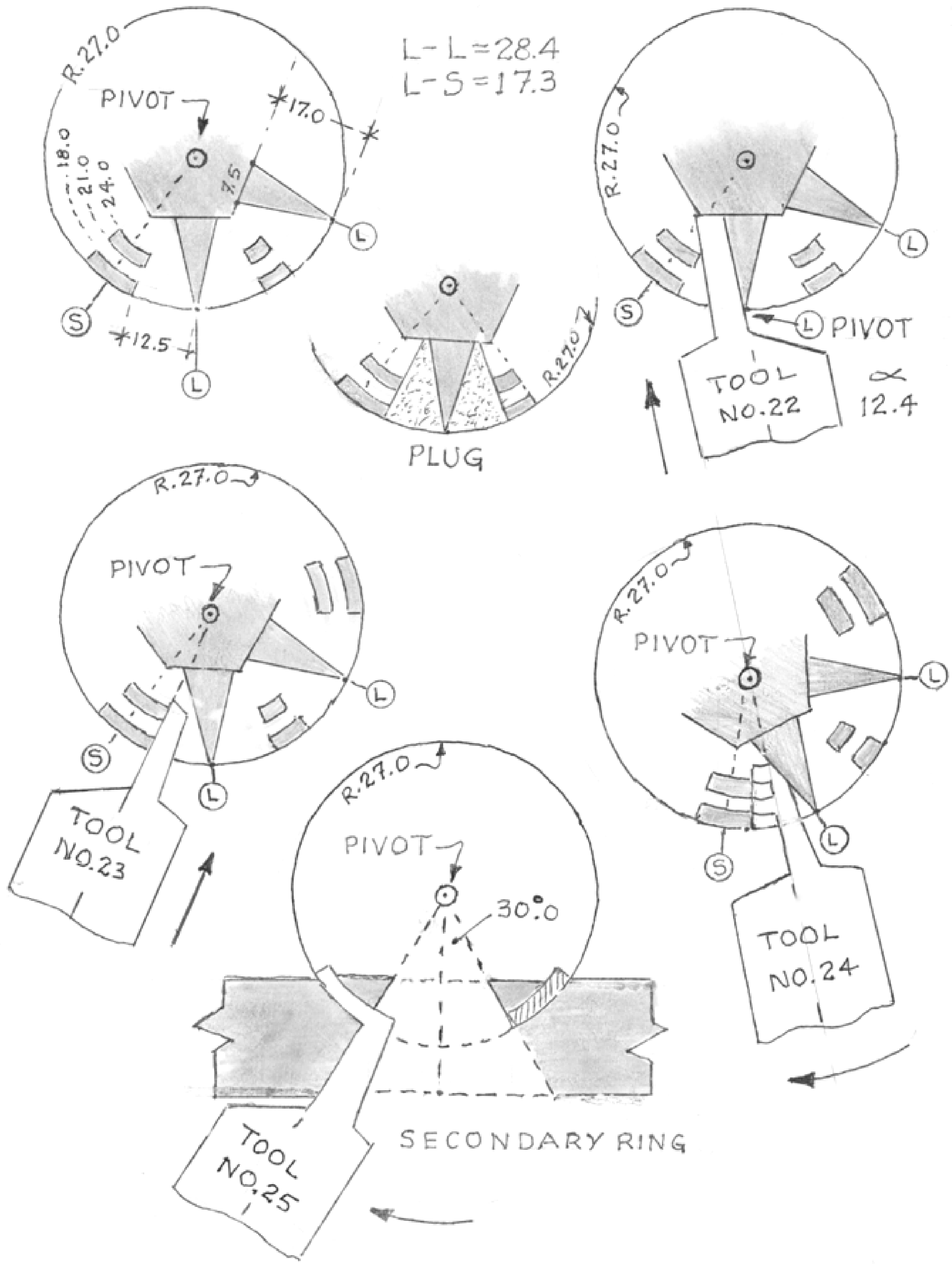
BASE FOR "SURPRISE"



ITEM NO. 34

TOOLS NOS. 22, 23, 24 AND 25.

CROSS-SECTION



Item N°41

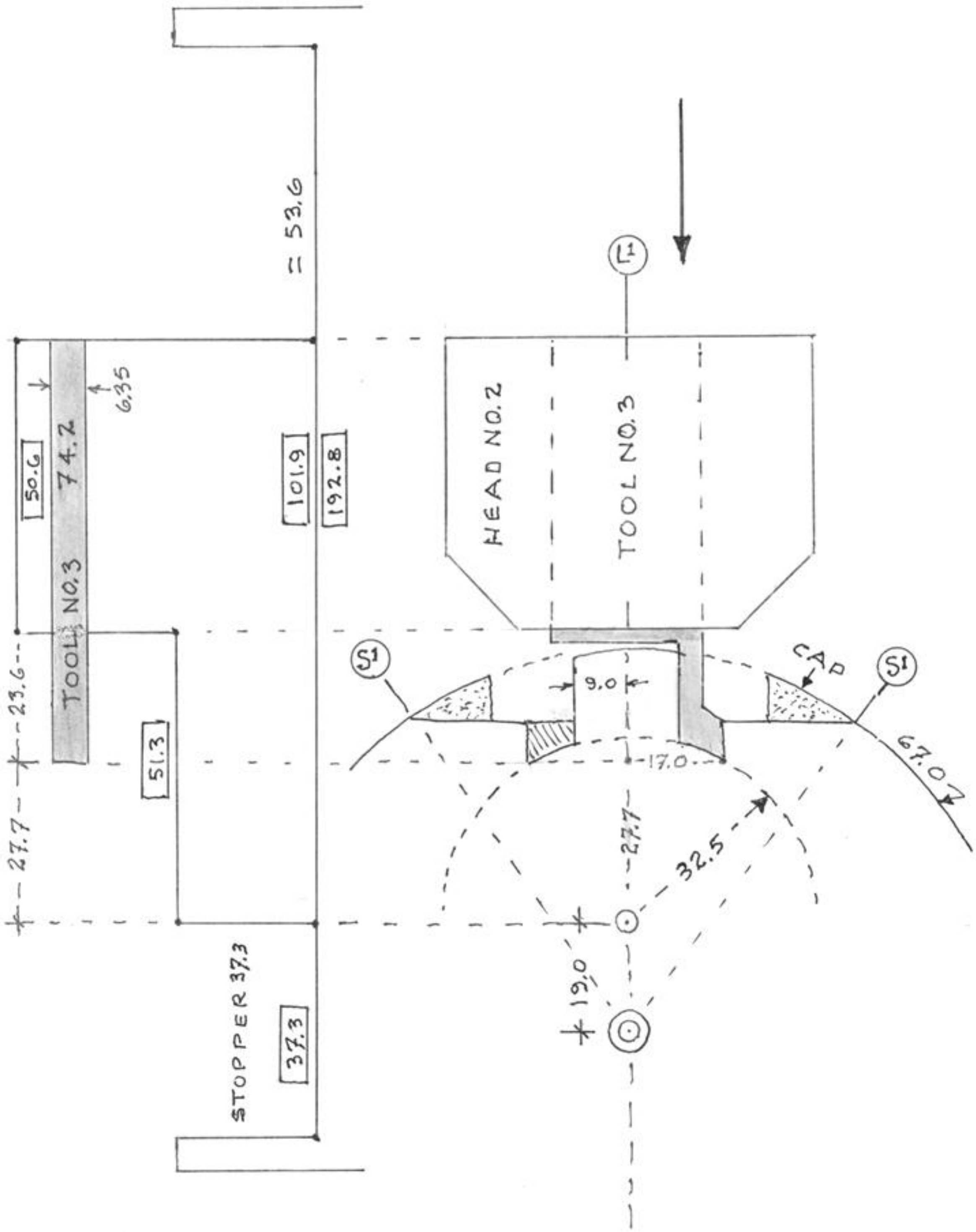
Details of tools N° 3 to 25

1- Form and dimensions.
2- Position of tool in sphere jig and stopper distance.
3- Position of sphere jig versus R.91.5 sphere.
4- Movement or rotation of sphere jig.
5- Note 1 : top edge of cutting end of tool to be at lathe center height.
6- Note 2 : except for the cutting end, the width of the tool inside the turning should be relieved so as not to rub on each side.
7- Note 3 : these tools are made for <u>my</u> sphere jig and for that <u>particular</u> turning only.
8- All distances in a rectangle are fixed dimensions of the sphere jig.
9- These drawings are rough hand drawings to approximate scale, they have to be redrawn very accurately on the simulation plate with the appropriate part of the cross-section.
10- For the rough cutting of the tools use the <u>dimensions</u> of the rough drawings, do not trace over.

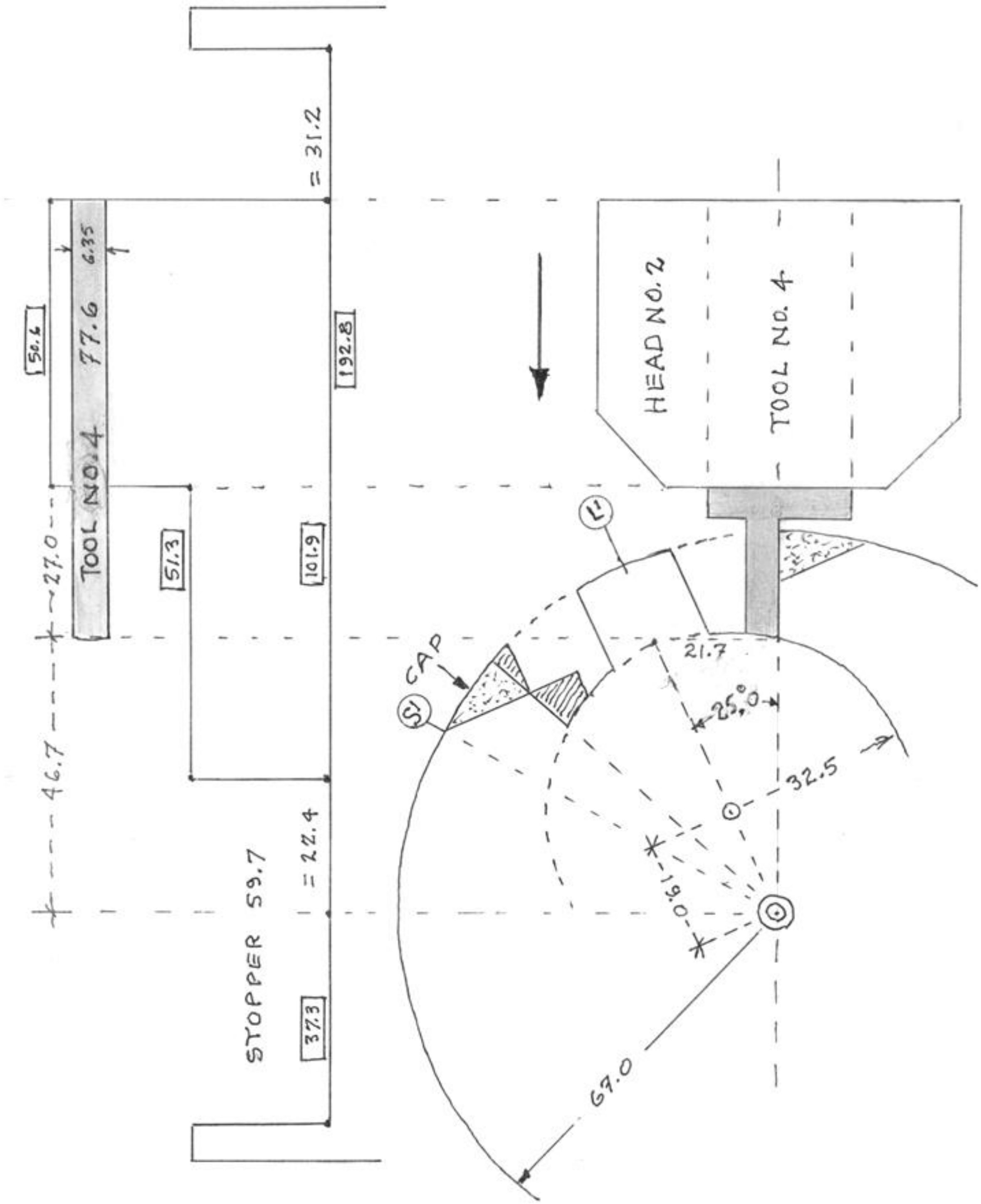
Item N°42

Tool N°	Item N°
3	43
4	44
5	45
6	46
7	47
8	48
9	49
10	50
11-12	51
13-14	52
15	53
16-17	54
18	55
19-20-21	56
22	57
23	58
24	59
25	60

ITEM NO. 43

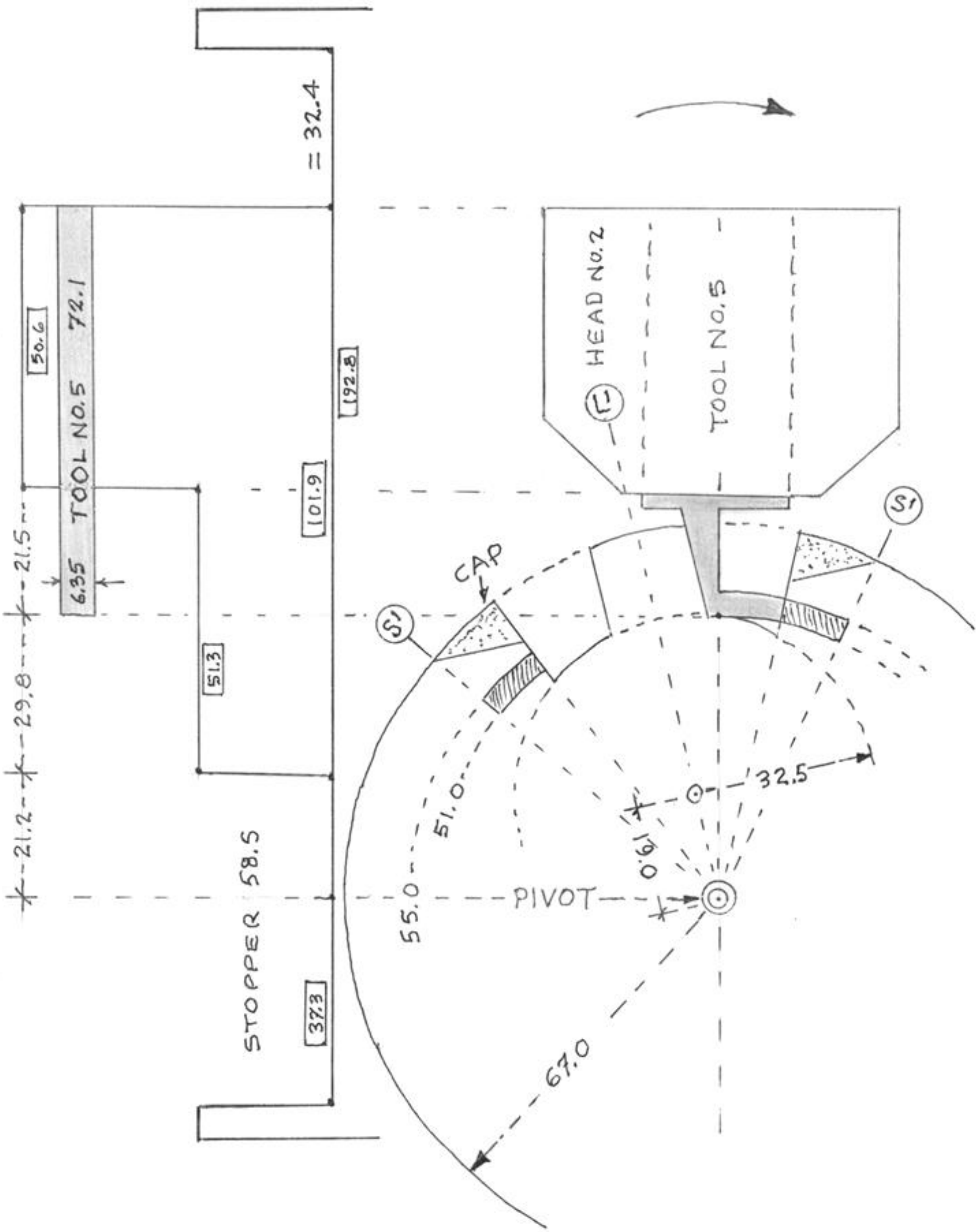

L1
HEAD NO.2
TOOL NO.3
TOOL NO.3
S1
S1
CAP
= 53.6
6.35
50.6
74.2
101.9
192.8
23.6
27.7
51.3
9.0
17.0
27.7
32.5
67.0
19.0
STOPPER 37.3
37.3

ITEM NO. 44

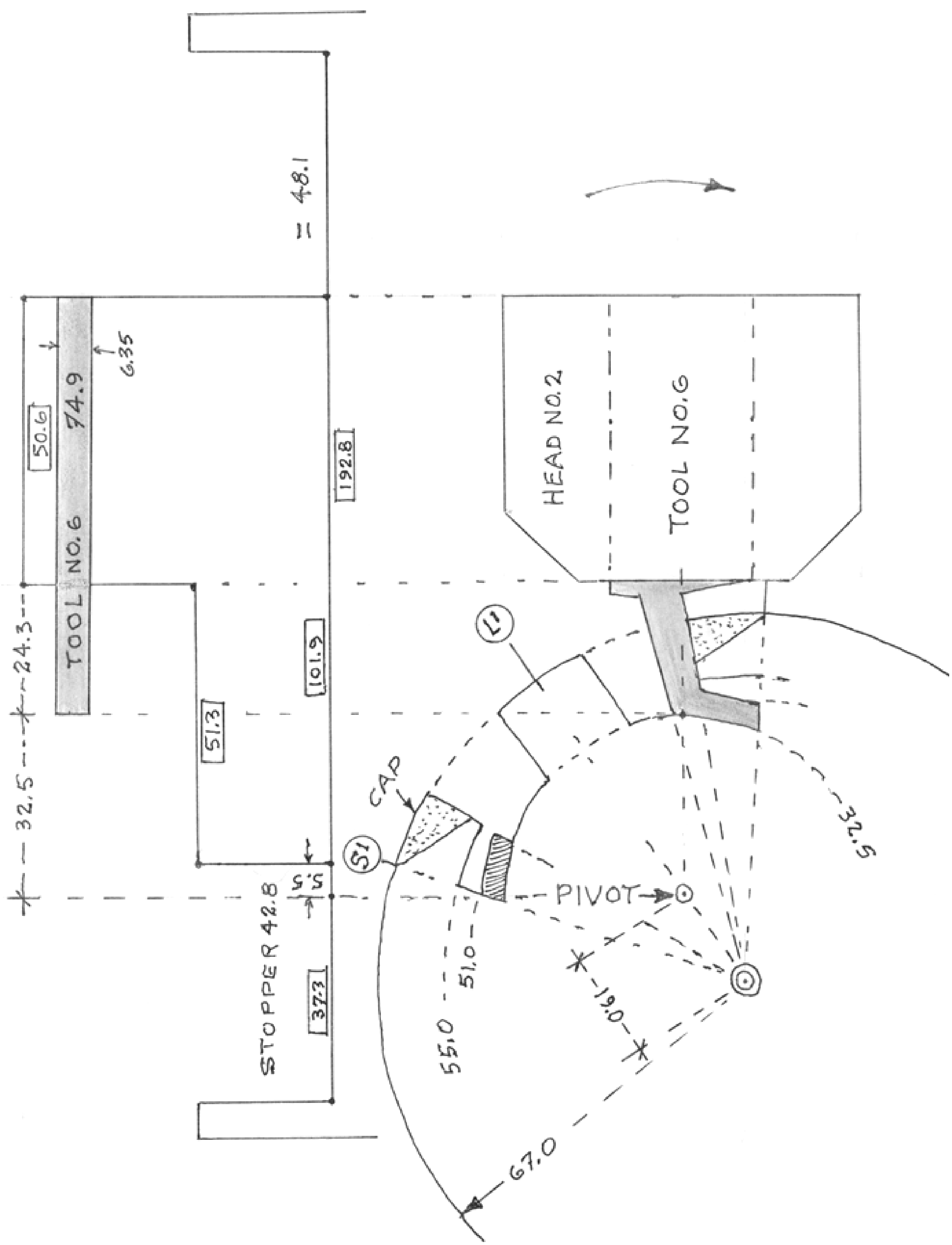


HEAD NO. 2
TOOL NO. 4
TOOL NO. 4
77.6
6.35
50.6
192.8
= 31.2
27.0
51.3
101.9
46.7
= 22.4
STOPPER 59.7
37.3
CAP
21.7
25.0
32.5
19.0
67.0

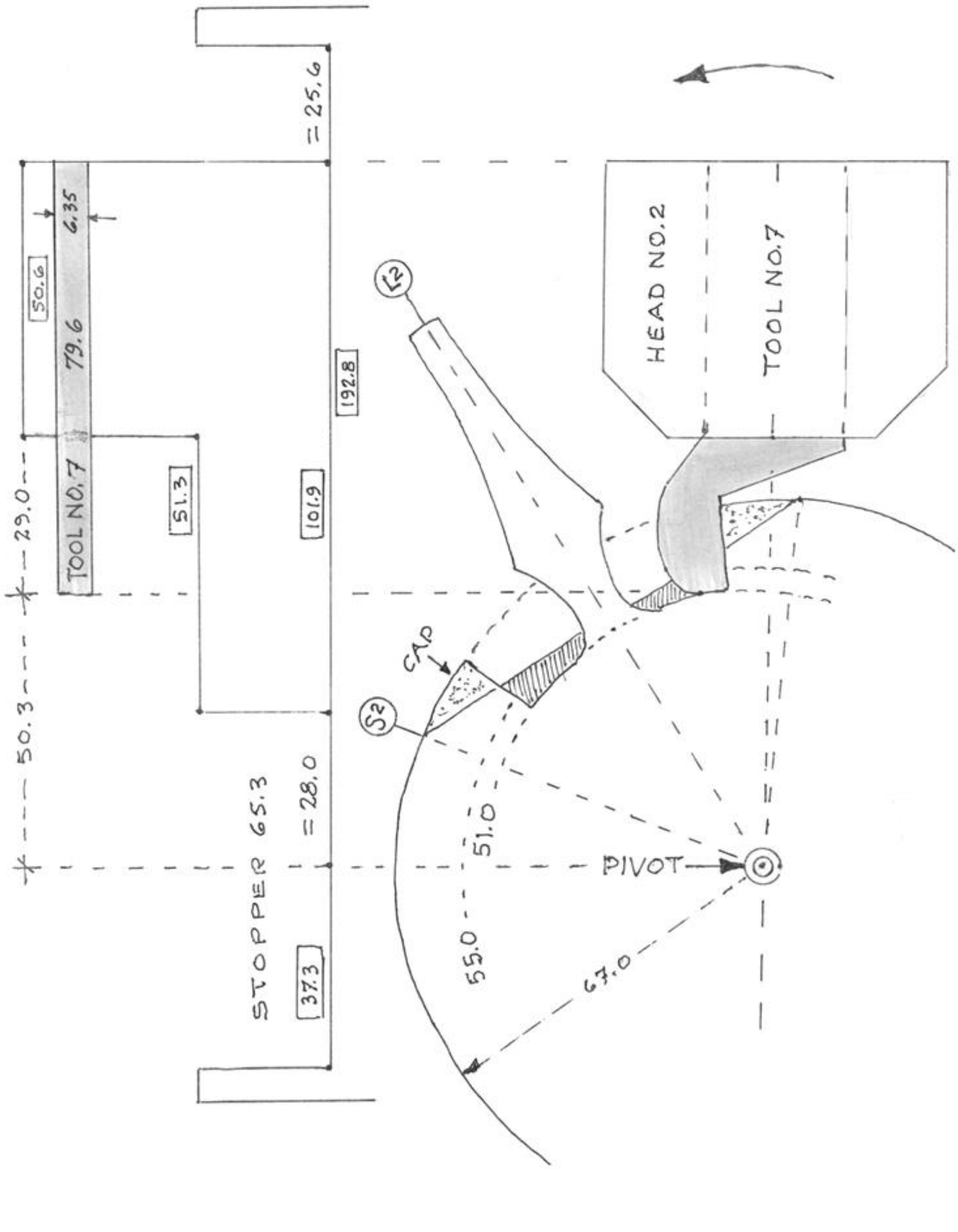
ITEM NO. 45


= 32.4
50.6
TOOL NO.5 72.1
192.8
101.9
21.5
6.35
29.8
51.3
21.2
STOPPER 58.5
37.3
HEAD NO.2
TOOL NO.5
L1
S1
CAP
S1
32.5
51.0
19.0
55.0
PIVOT
67.0

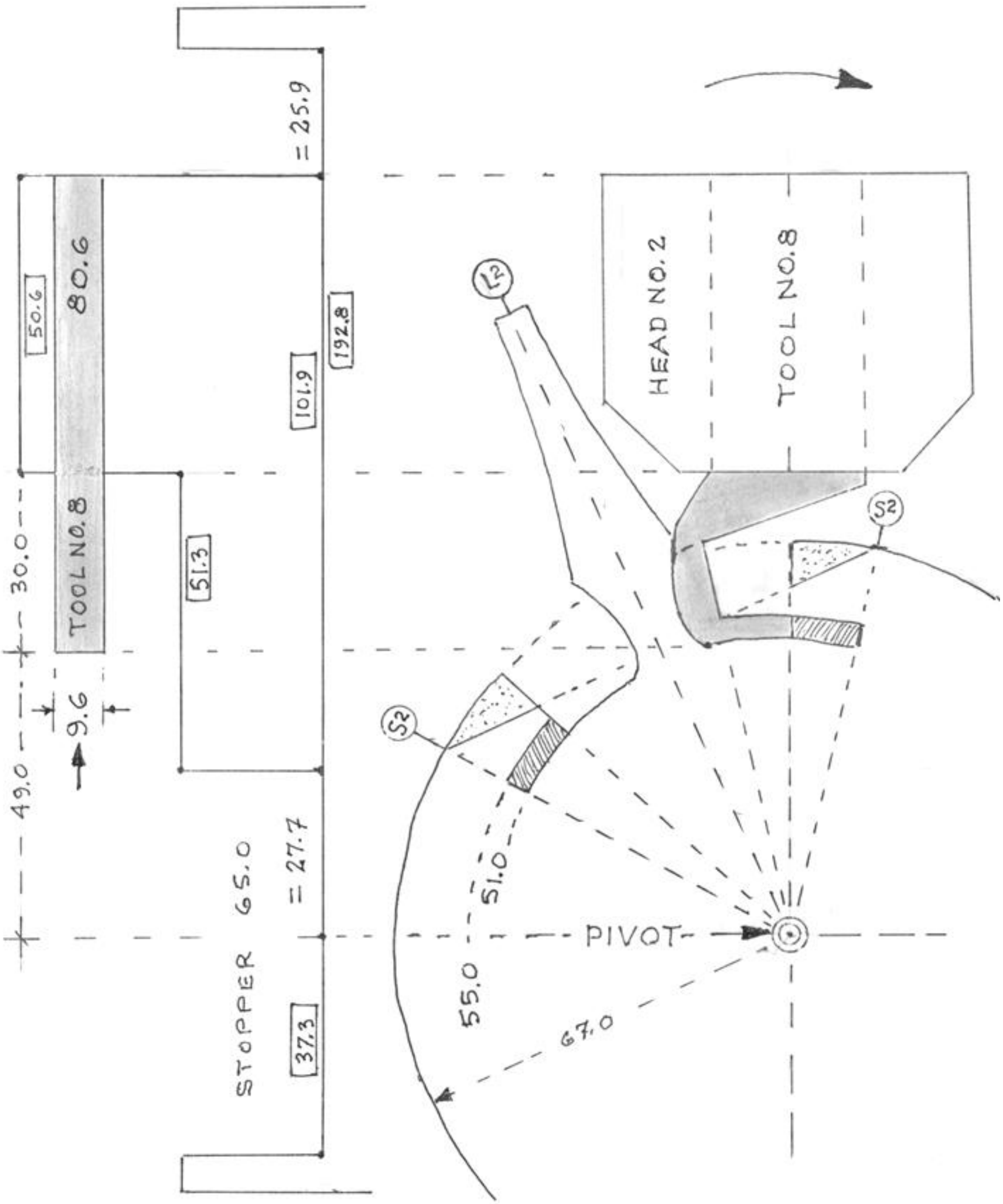
ITEM NO. 46


48.1
TOOL NO.6 74.9
50.6
6.35
192.8
HEAD NO.2
TOOL NO.6
24.3
101.9
51.3
32.5
CAP
51
17
PIVOT
5.5
STOPPER 42.8
37.3
51.0
55.0
19.0
67.0
32.5

ITEM NO. 47

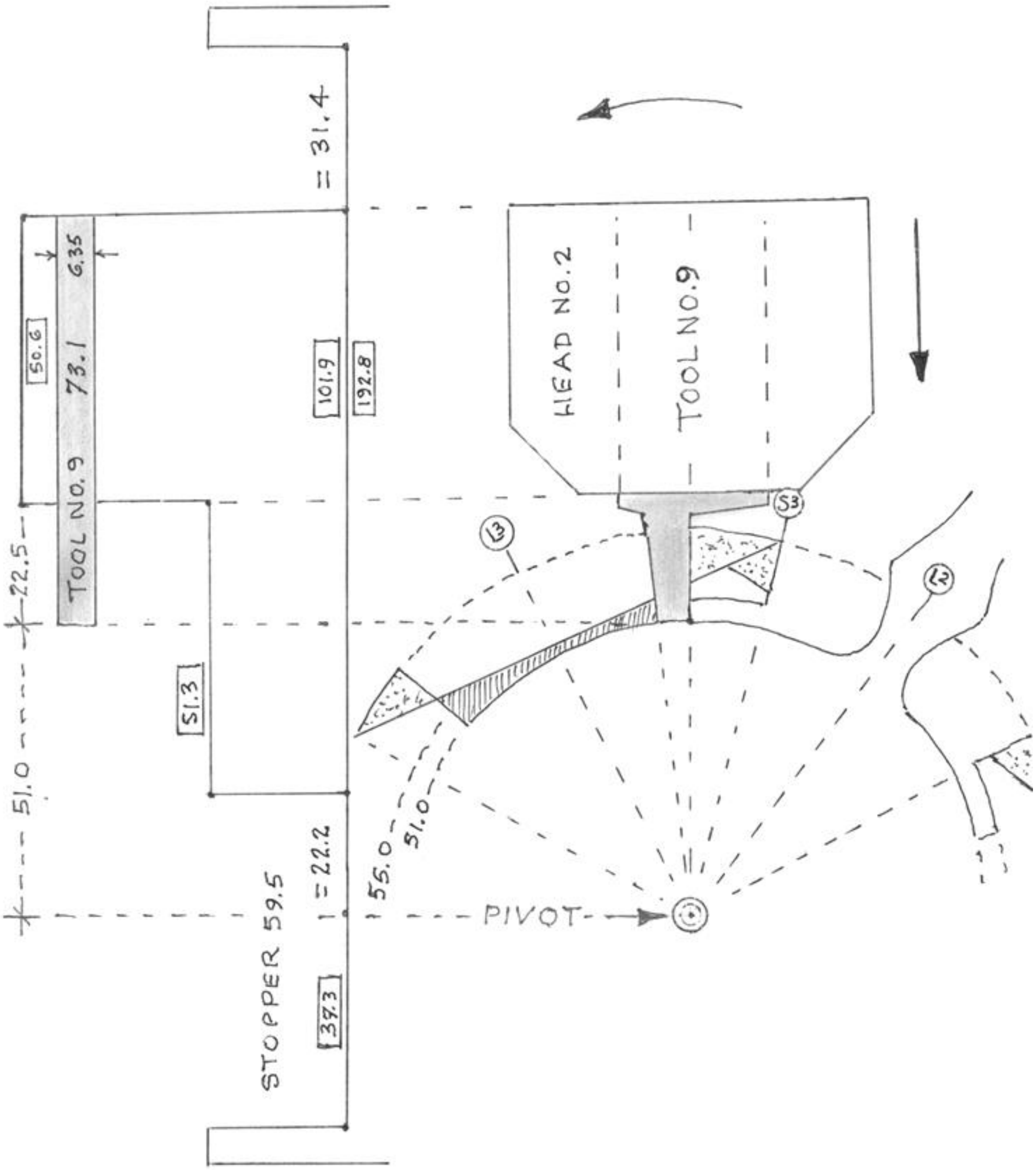

=25,6
6,35
50.6
79.6
192.8
TOOL NO.7
29.0
51.3
101.9
K2
HEAD NO.2
TOOL NO.7
CAP
S2
50.3
STOPPER 65.3
=28.0
51.0
PIVOT
55.0
67.0
37.3

ITEM NO. 48



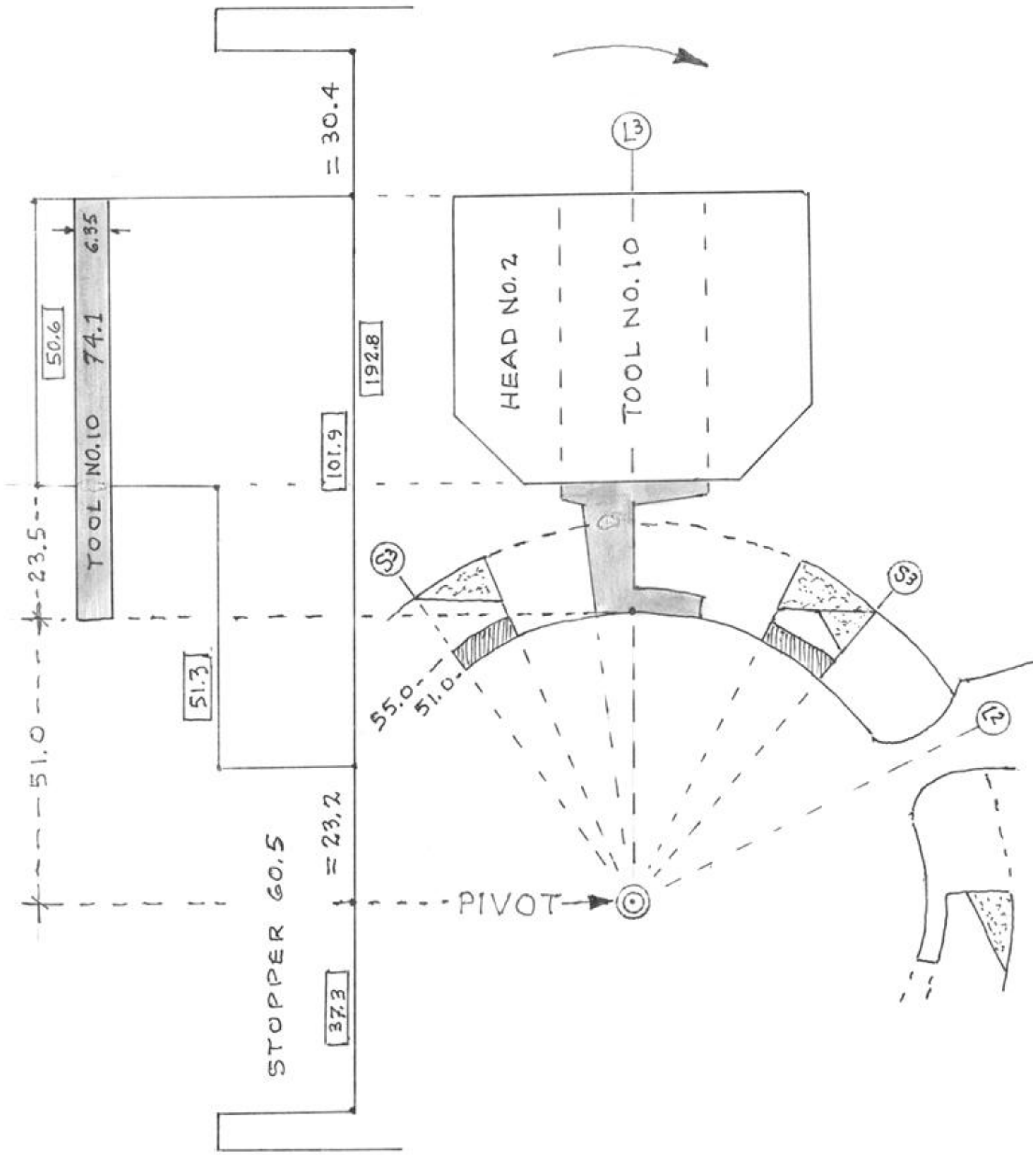
= 25.9
HEAD NO. 2
TOOL NO. 8
80.6
50.6
192.8
101.9
TOOL NO. 8
30.0
51.3
9.6
49.0
STOPPER 65.0
= 27.7
37.3
PIVOT
51.0
55.0
67.0
L2
S2
S2

ITEM NO. 49



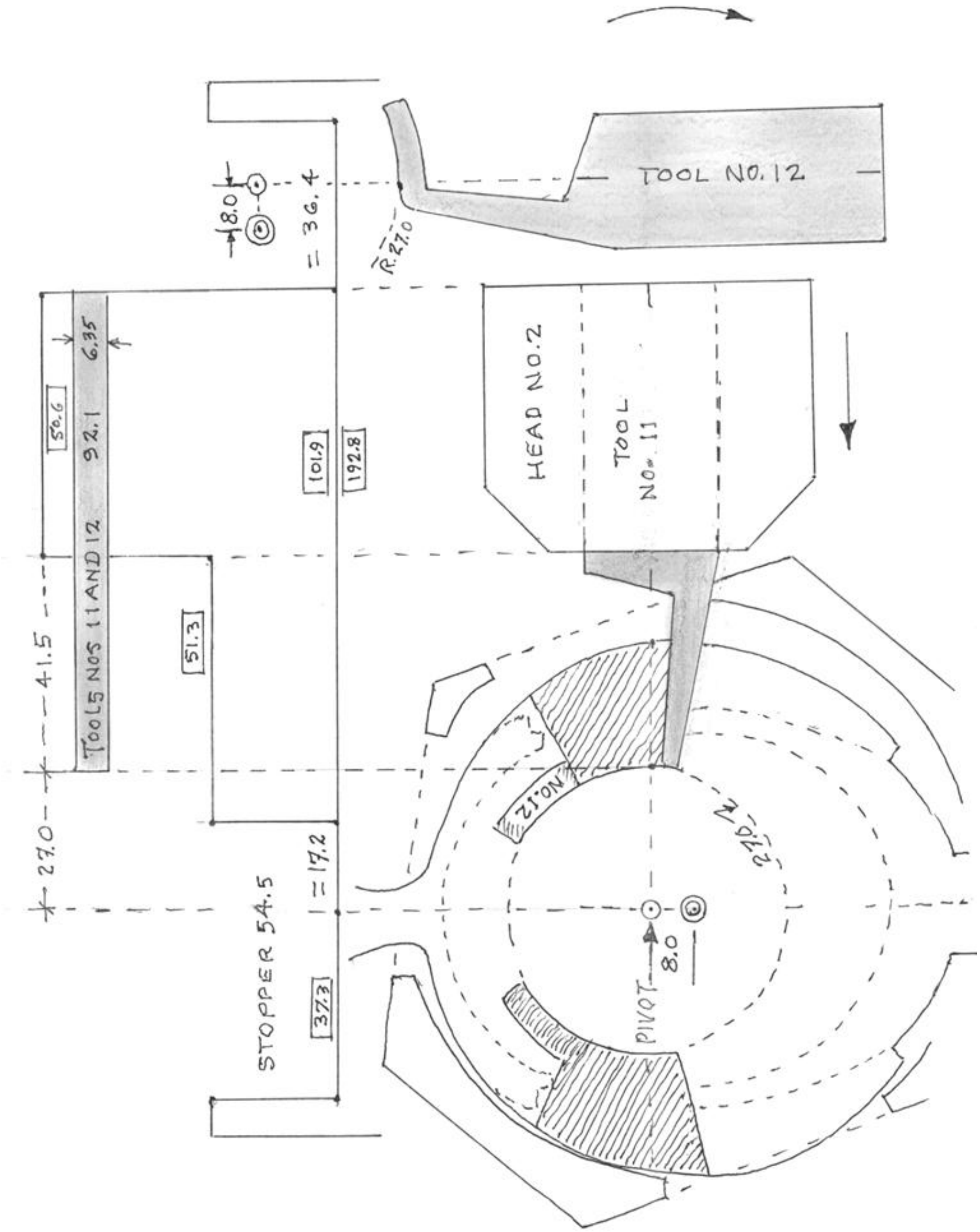
= 31.4
HEAD No.2
TOOL No.9
TOOL No.9
73.1
50.6
6.35
101.9
192.8
22.5
51.0
51.3
= 22.2
STOPPER 59.5
39.3
55.0
51.0
PIVOT
13
12
53

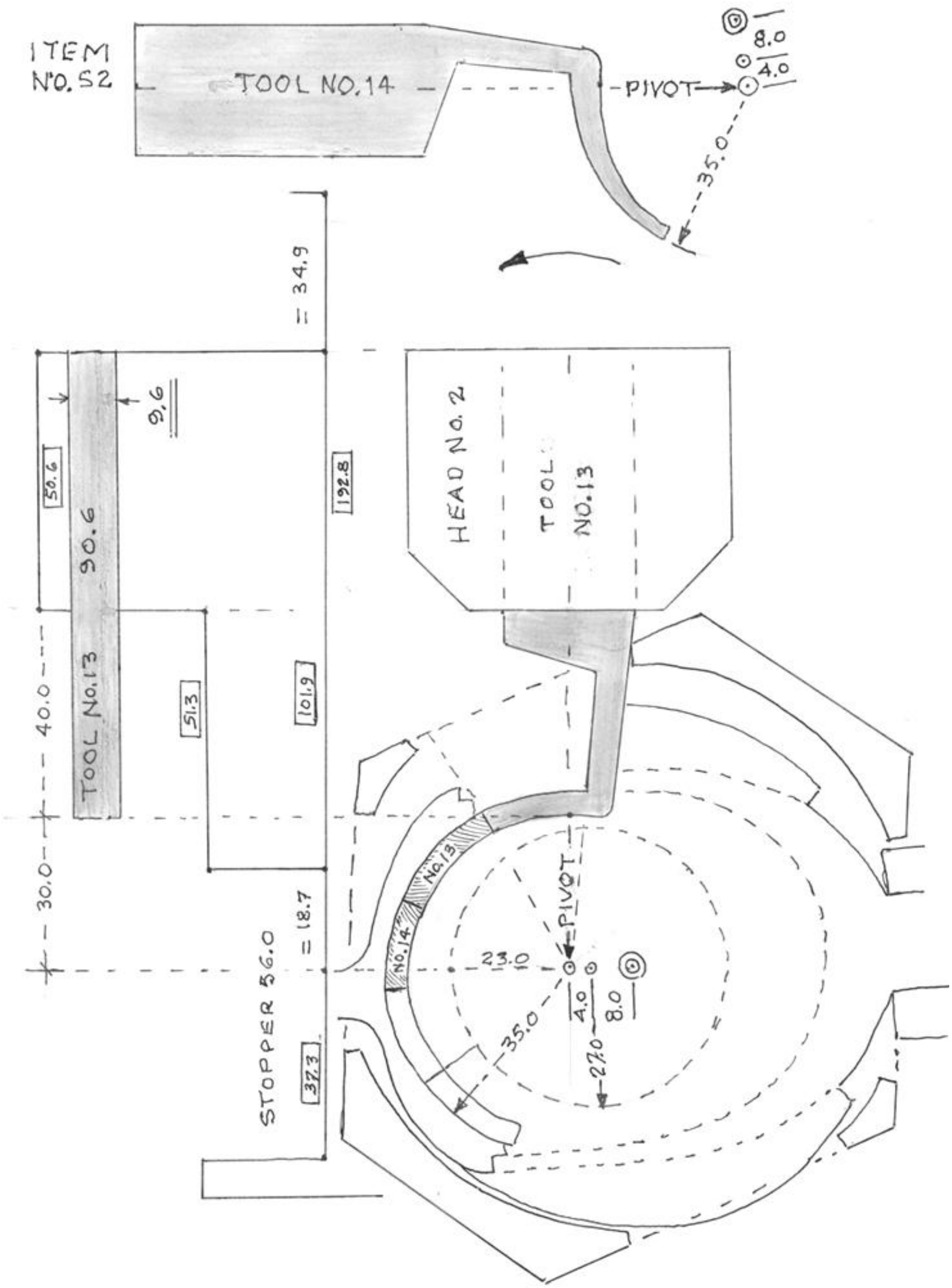
ITEM NO. 50



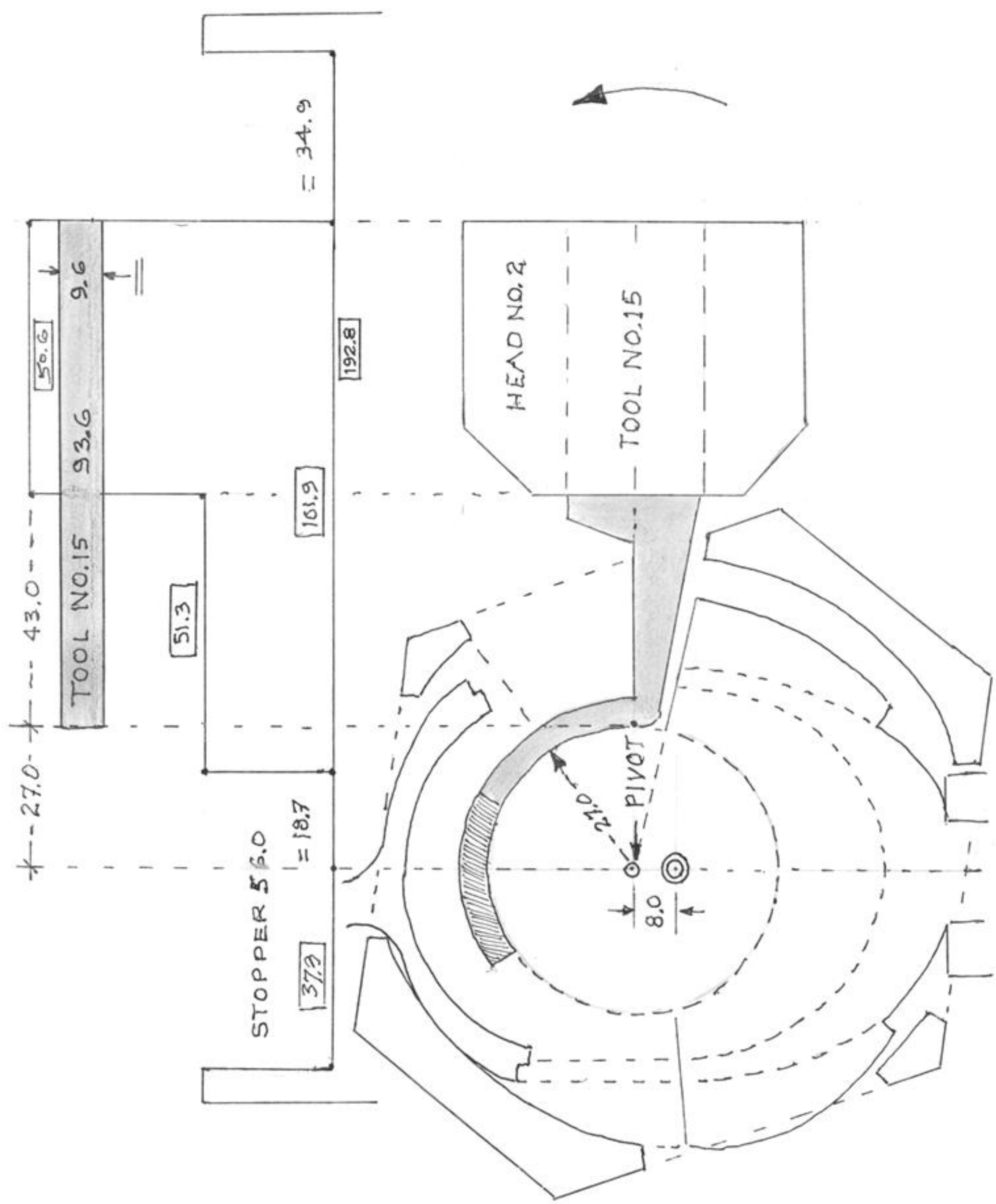
L3
HEAD NO. 2
TOOL NO. 10
= 30.4
192.8
101.9
50.6
74.1
6.35
TOOL NO.10
23.5
51.0
51.3
S3
S3
55.0
51.0
L2
STOPPER 60.5
= 23.2
37.3
PIVOT

ITEM NO. 51

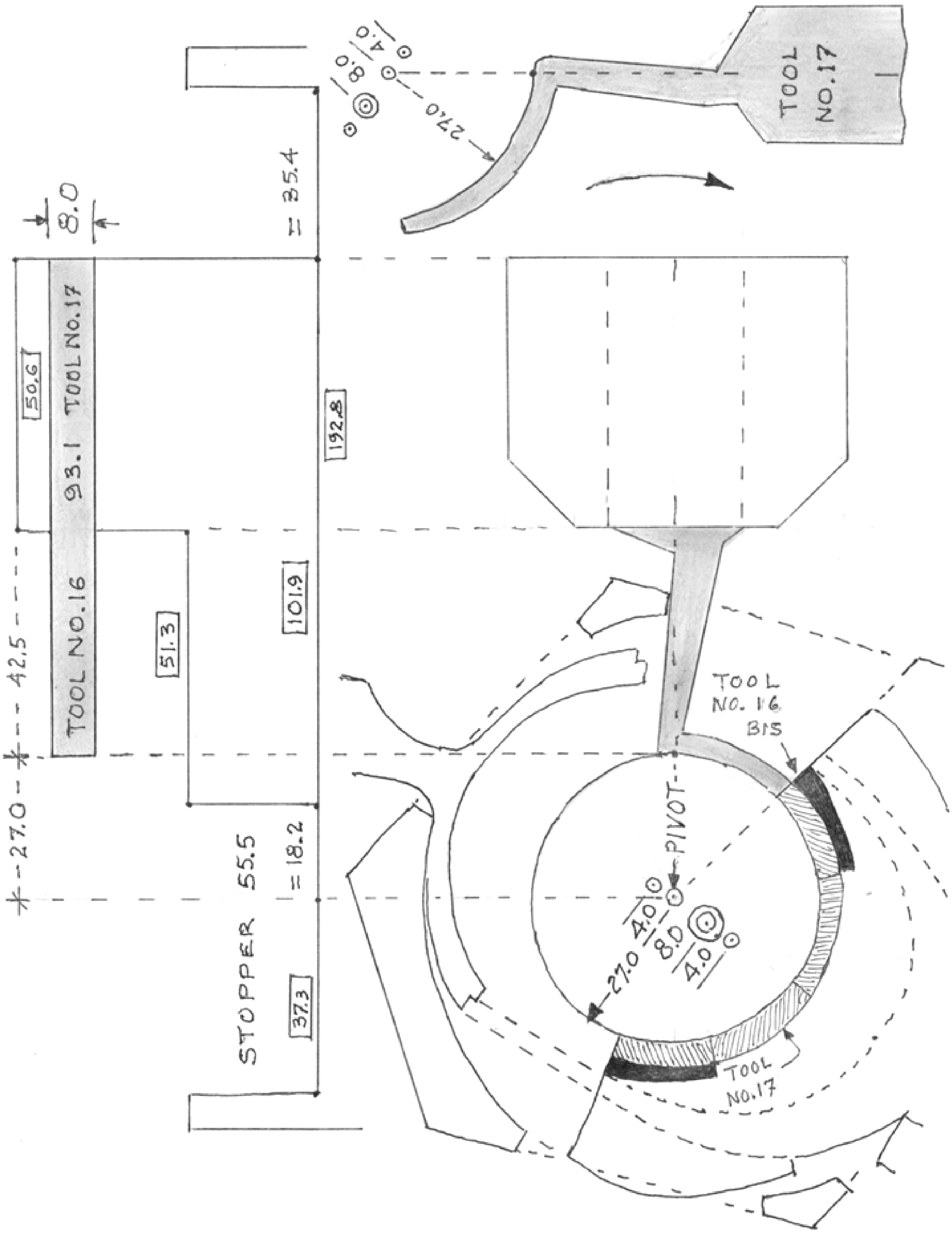

TOOL NO. 12
HEAD NO. 2
TOOL
No. 11
TOOLS NOS 11 AND 12
92.1
6.35
50.6
101.9
192.8
51.3
41.5
27.0
8.0
= 36.4
R. 27.0
= 17.2
STOPPER 54.5
37.3
NO. 12
27.0
PIVOT
8.0


ITEM
No. 52
TOOL NO.14
PIVOT
8.0
4.0
35.0
= 34.9
HEAD No. 2
TOOL
No.13
9.6
50.6
90.6
192.8
40.0
TOOL No.13
51.3
101.9
30.0
STOPPER 56.0
= 18.7
37.3
No.13
No.14
PIVOT
23.0
4.0
8.0
35.0
27.0

ITEM NO. 53

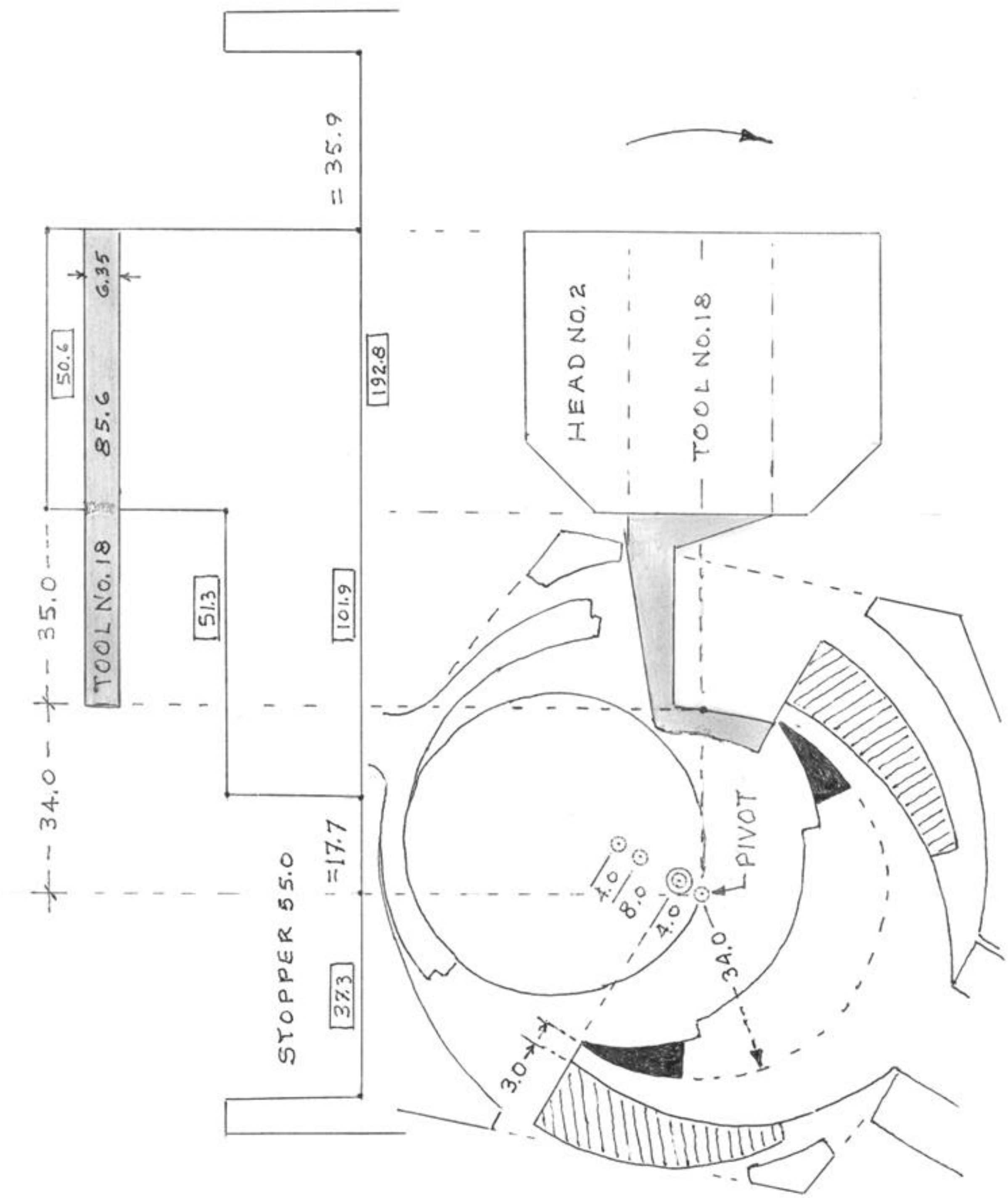


ITEM NO. 54

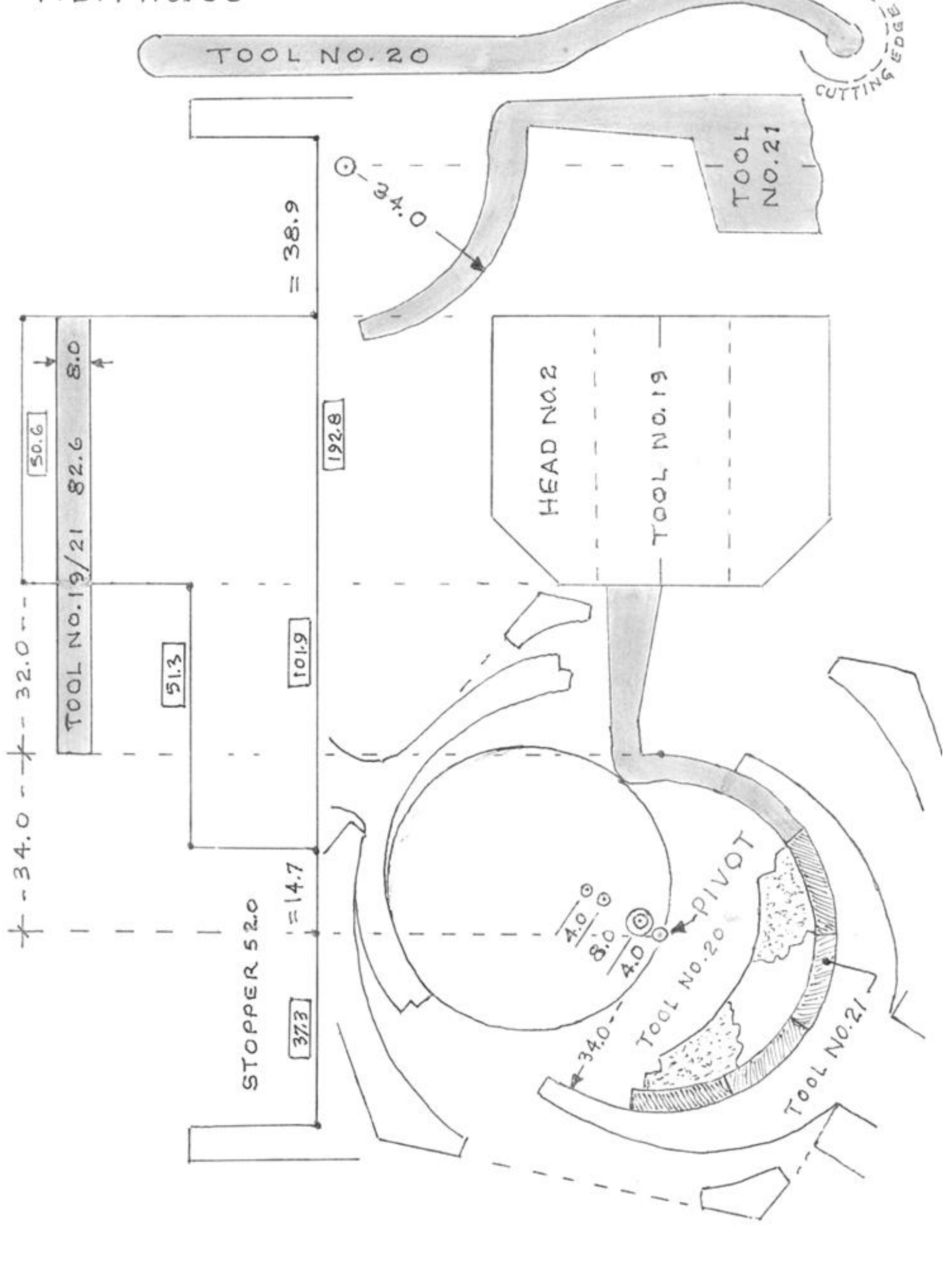


TOOL NO.17
27.0
4.0
8.0
= 35.4
8.0
50.6
TOOL NO.17
93.1
192.8
TOOL NO.16
42.5
27.0
51.3
101.9
= 18.2
STOPPER 55.5
37.3
PIVOT
TOOL NO. 16 BIS
TOOL NO.17

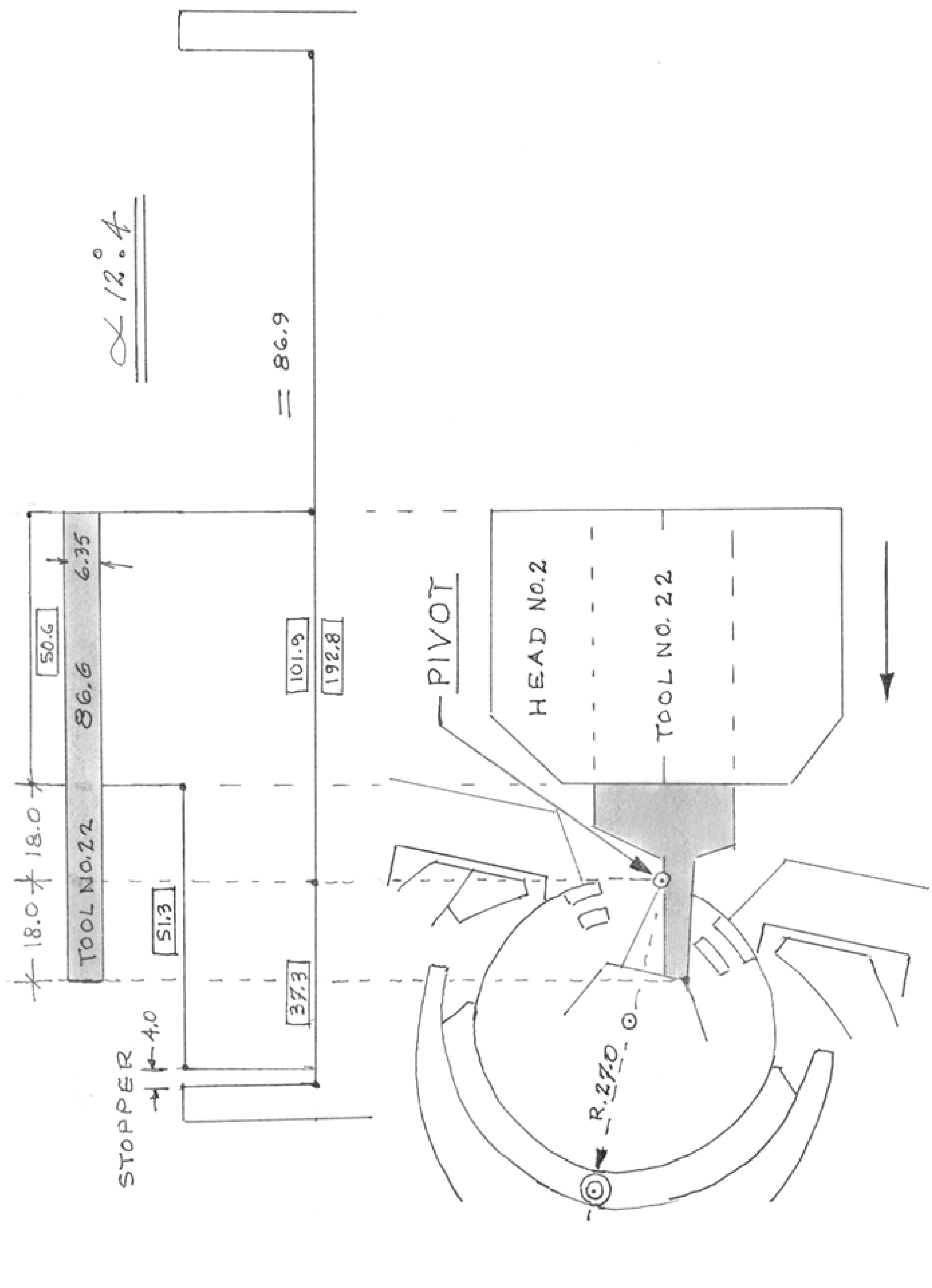
ITEM NO.55


=35.9
6.35
50.6
85.6
192.8
TOOL No.18
35.0
51.3
101.9
34.0
STOPPER 55.0
=17.7
37.3
HEAD No.2
TOOL No.18
PIVOT
4.0
8.0
4.0
34.0
3.0

ITEM NO. 56

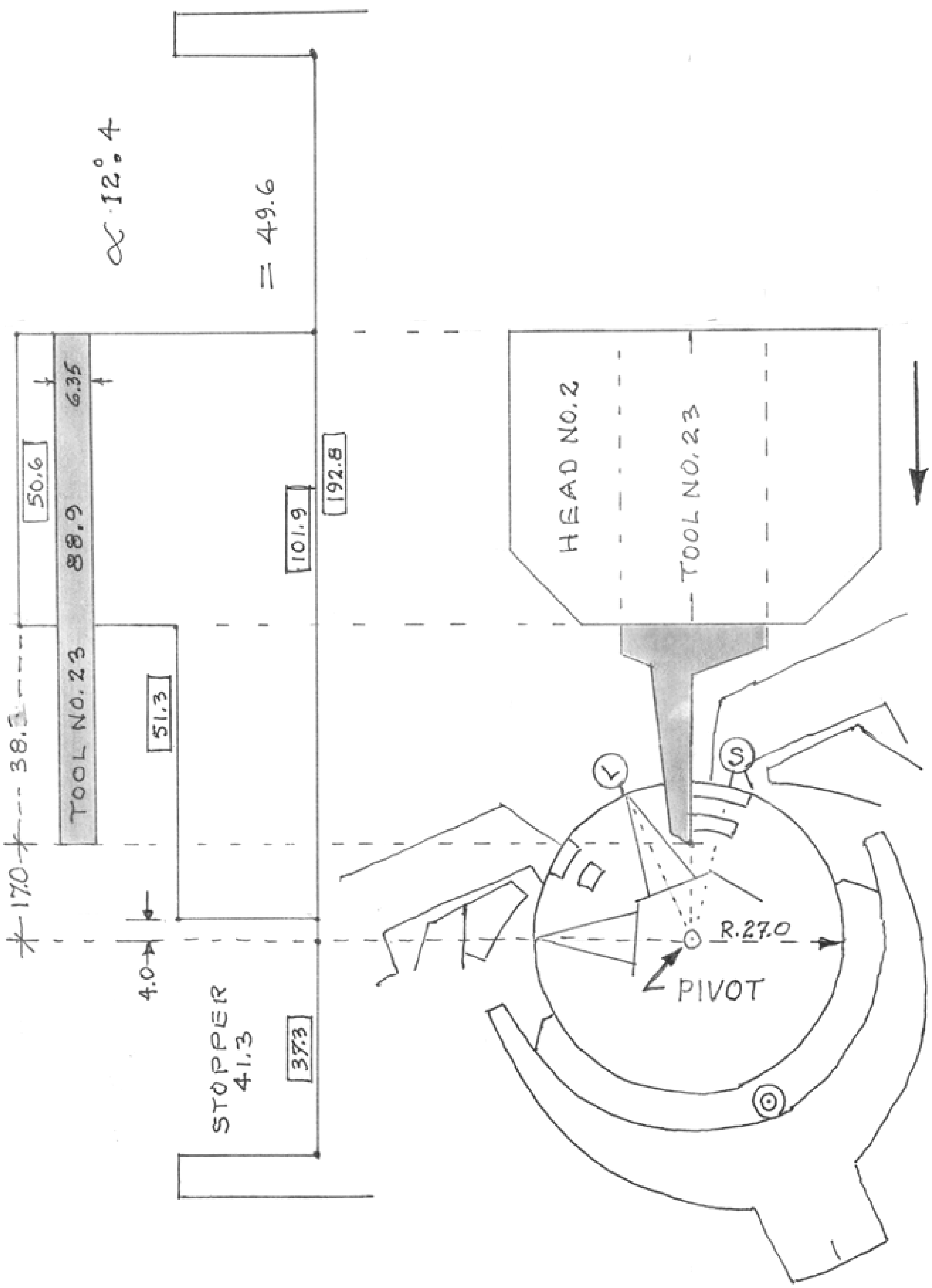

TOOL NO. 20
CUTTING EDGE
TOOL NO.21
34.0
= 38.9
8.0
50.6
82.6
TOOL NO.19/21
192.8
HEAD NO.2
TOOL NO.19
32.0
34.0
51.3
101.9
= 14.7
STOPPER 52.0
37.3
4.0
8.0
4.0
PIVOT
TOOL NO.20
34.0
TOOL NO.21

ITEM NO. 57

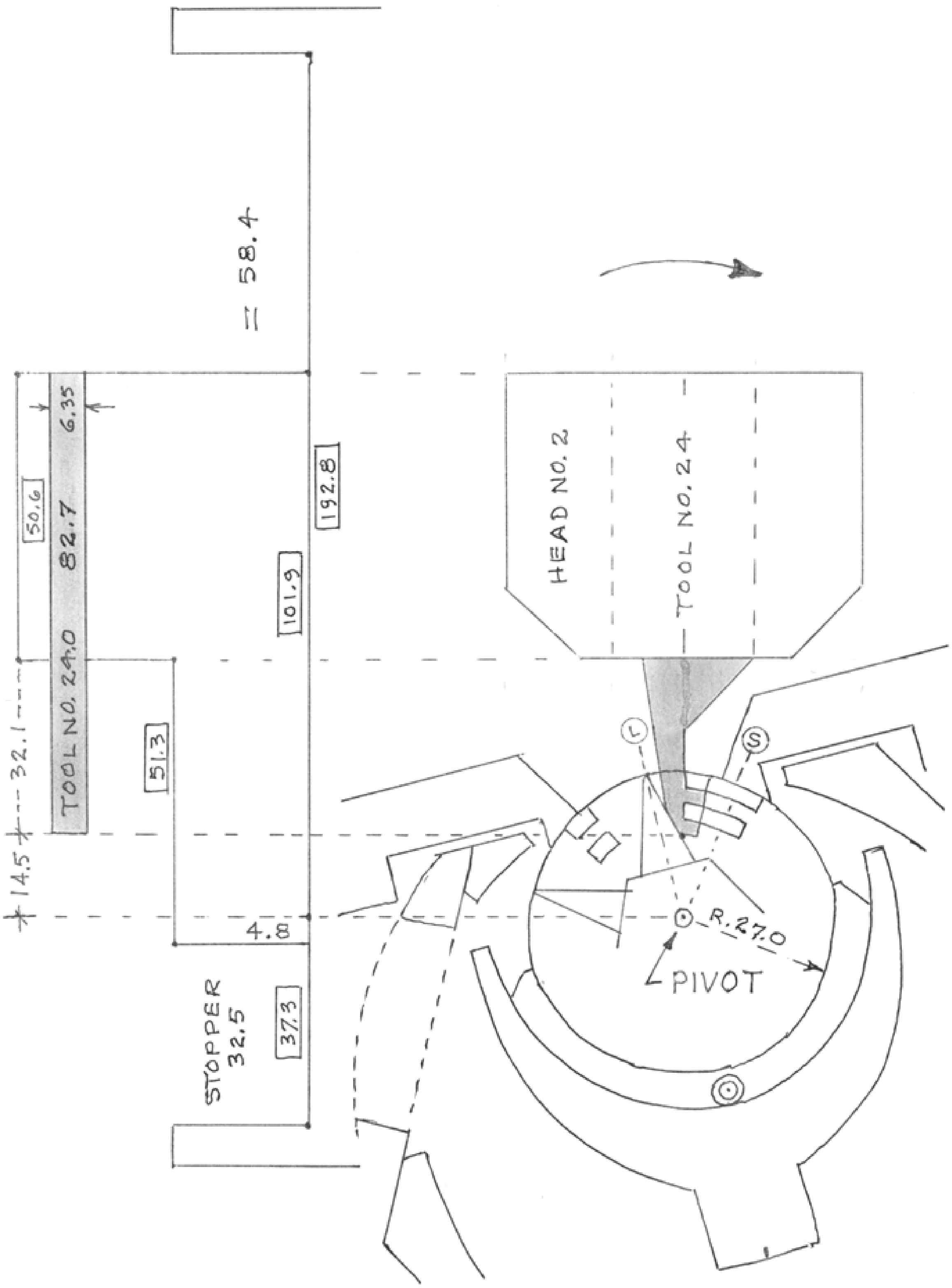


∠ 12.4°
= 86.9
6.35
50.6
86.6
TOOL NO.22
18.0
18.0
51.3
101.9
192.8
37.3
4.0
STOPPER
PIVOT
HEAD NO.2
TOOL NO. 22
R.27.0

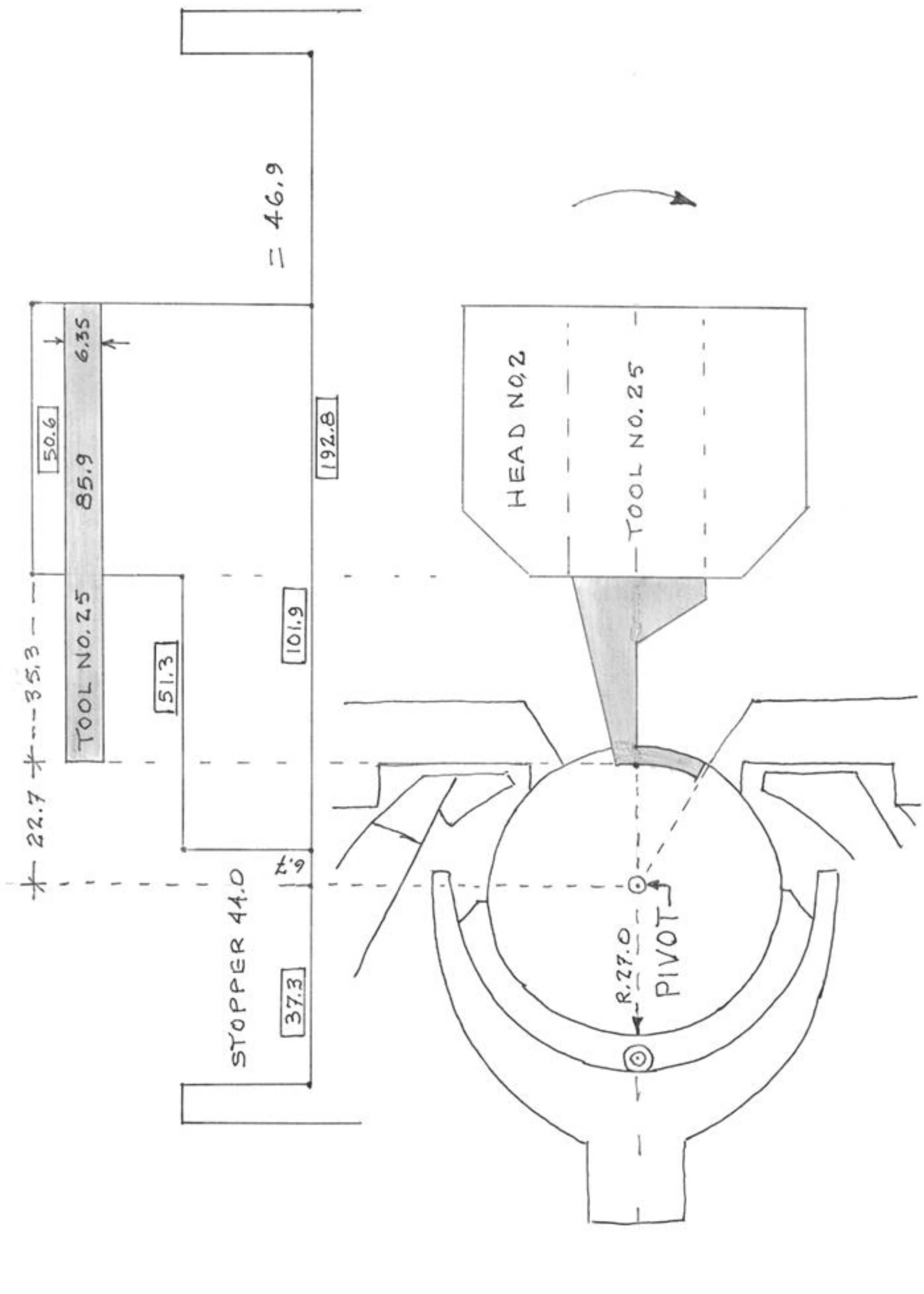
ITEM NO. 58


α 12°.4
= 49.6
50.6
88.9
6.35
TOOL NO. 23
192.8
101.9
51.3
17.0
4.0
STOPPER
41.3
37.3
HEAD NO. 2
TOOL NO. 23
L
S
R. 27.0
PIVOT

ITEM NO. 59


= 58.4
6.35
50.6
82.7
TOOL NO. 24.0
192.8
101.9
32.1
51.3
14.5
4.8
STOPPER
32.5
37.3
HEAD NO. 2
TOOL NO. 24
L
S
R. 27.0
PIVOT

ITEM NO. 60



= 46.9
6.35
50.6
85.9
192.8
HEAD NO.2
TOOL NO. 25
TOOL NO. 25
101.9
51.3
35.3
22.7
6.7
STOPPER 44.0
37.3
R.27.0
PIVOT

Tour de Force

J - “Genesis”

Claude LETHIECQ

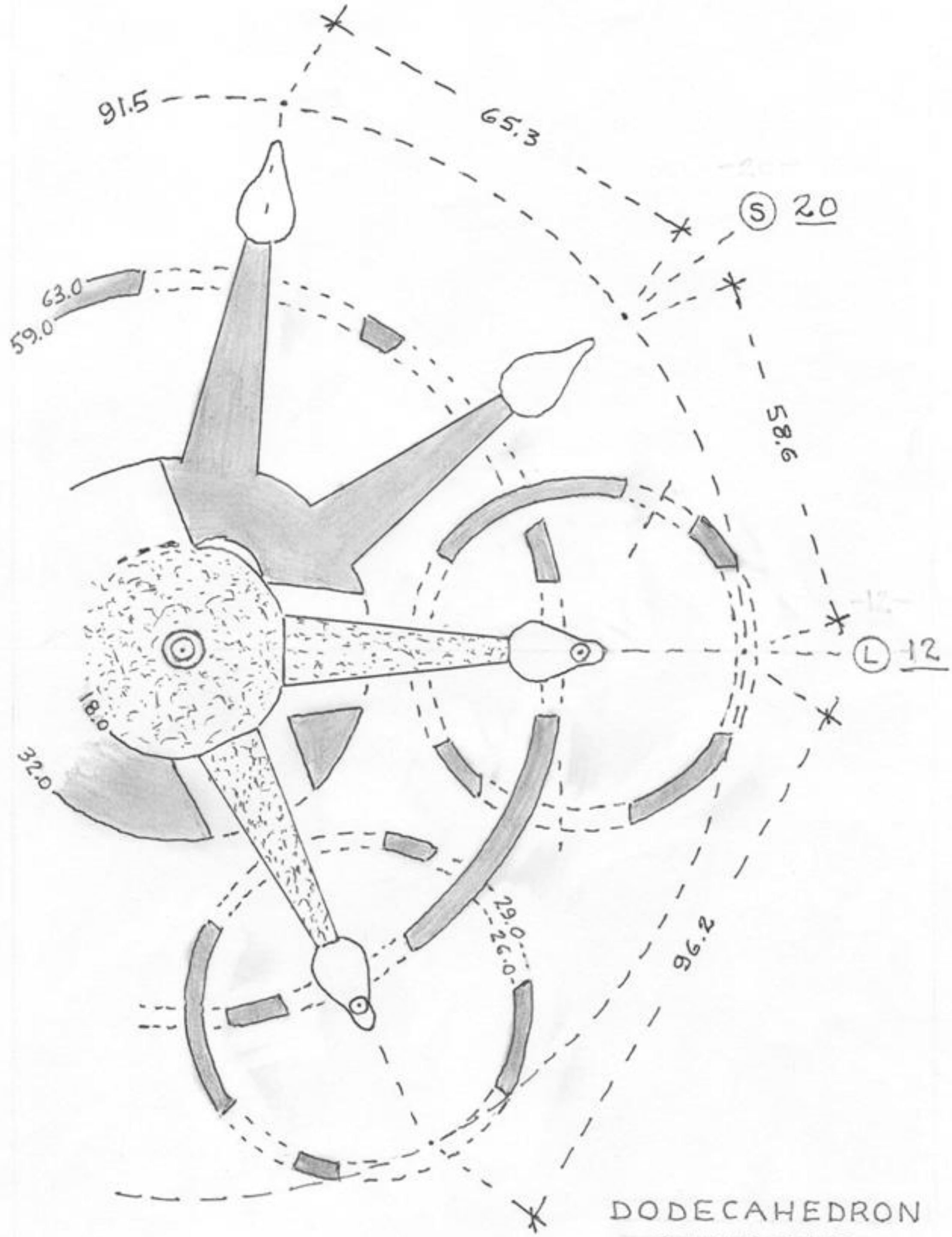
~ *Sequence of operations* ~

“S” (20 spikes Star)

Item

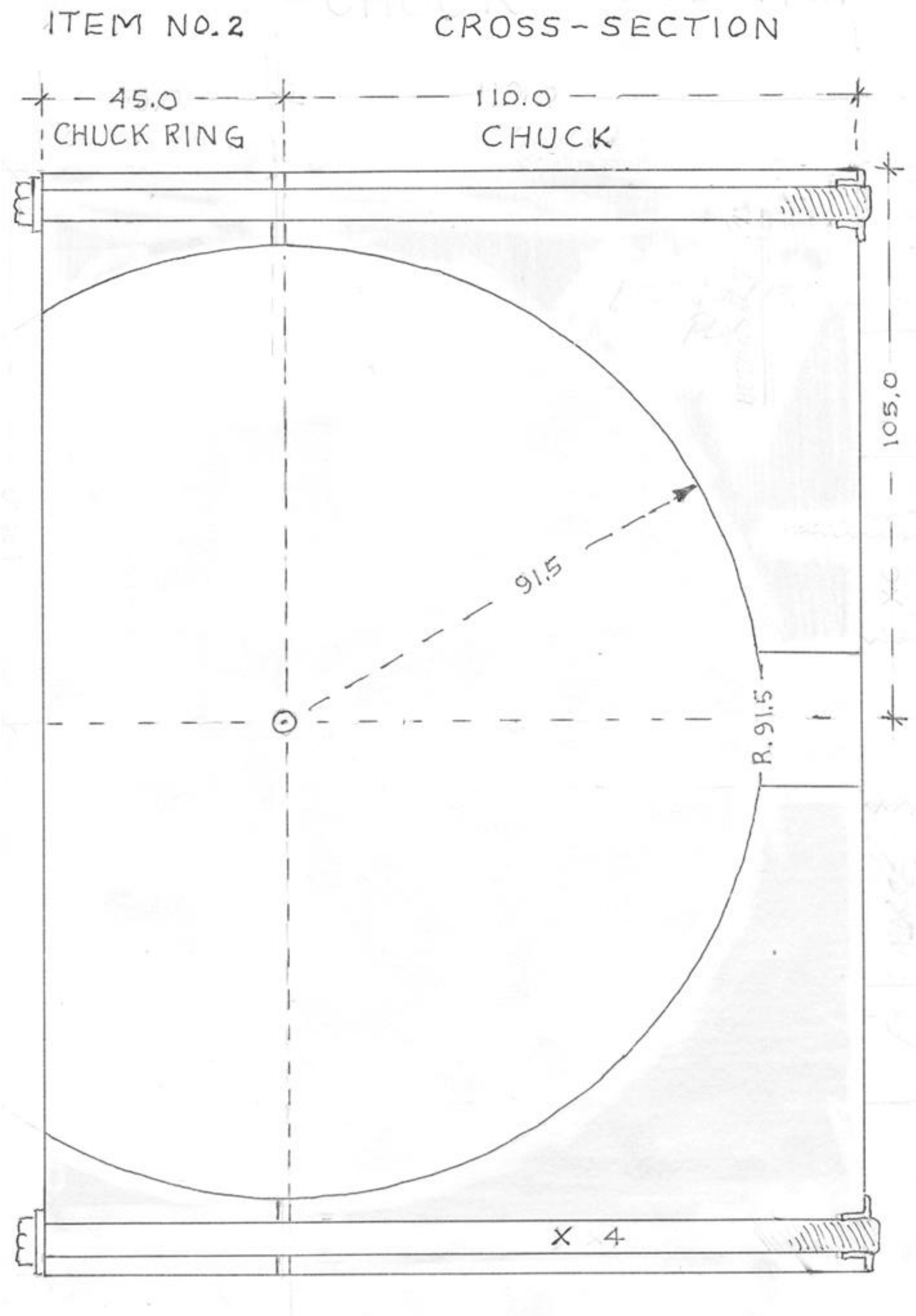
20. Draw cross-section of the turning
21. Draw cross-section of the chuck
22. Make tool N°1 and chuck
23. Make tool N°2 and chuck ring
24. With head N°1 turn R.91.5 sphere
25. Mark 12 Ⓛ points and 20 Ⓢ points on sphere
26. Set sphere in chuck, line up an Ⓢ point and set chuck ring
27. Drill hole Ø25.4 depth 22.9 at center
28. Cut wings
29. Mark with center drill
30. Drill hole Ø2.78 (7/64”), set nail Ø2.65 ($2^{1/2}$”)
31. Use plug cutter
32. Make and use tool N°3
33. Set plug
34. Repeat items N°5 to 13 included till all 20 Ⓢ spikes are done

ITEM NO. 1 CROSS-SECTION

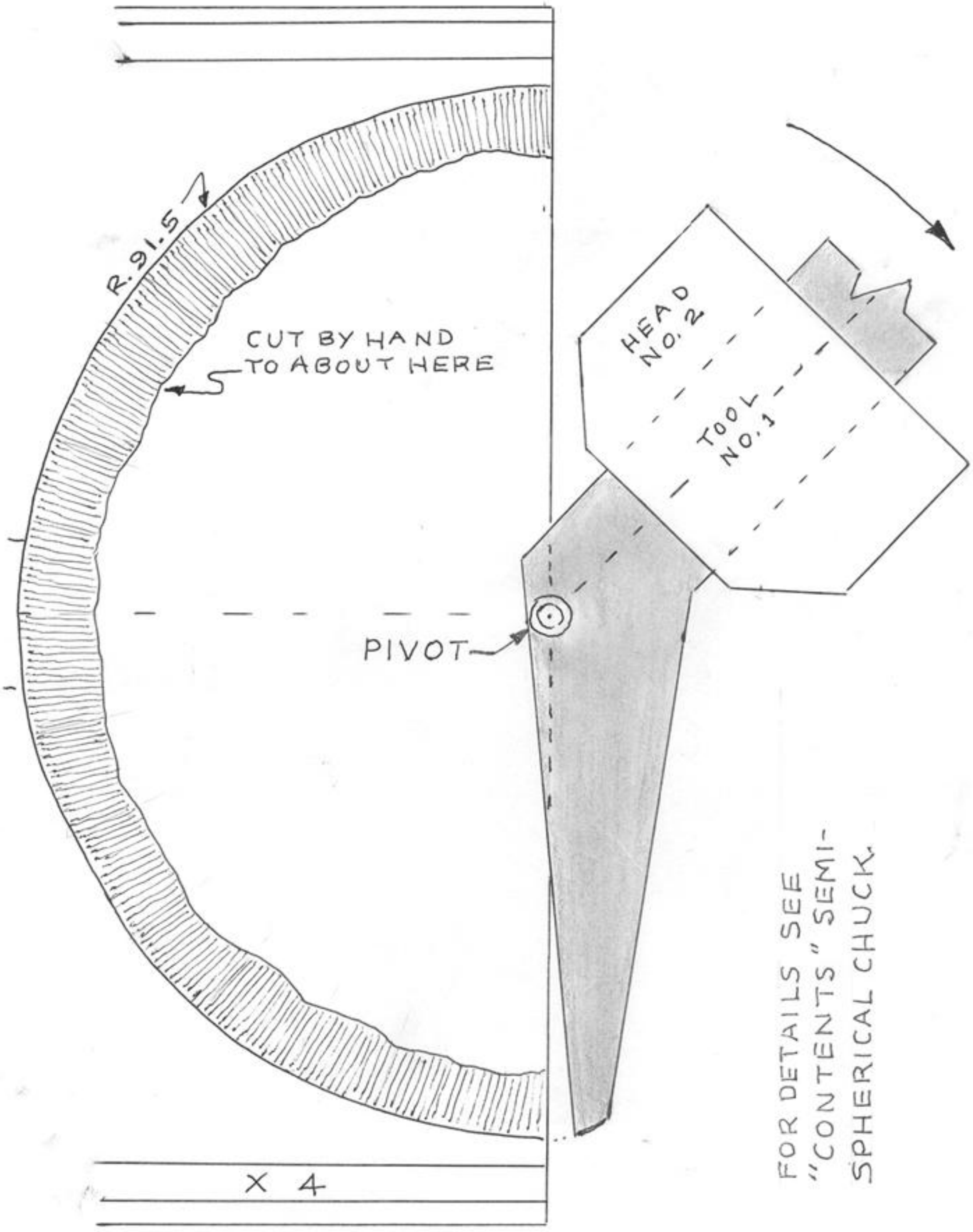


DODECAHEDRON DIVISIONS

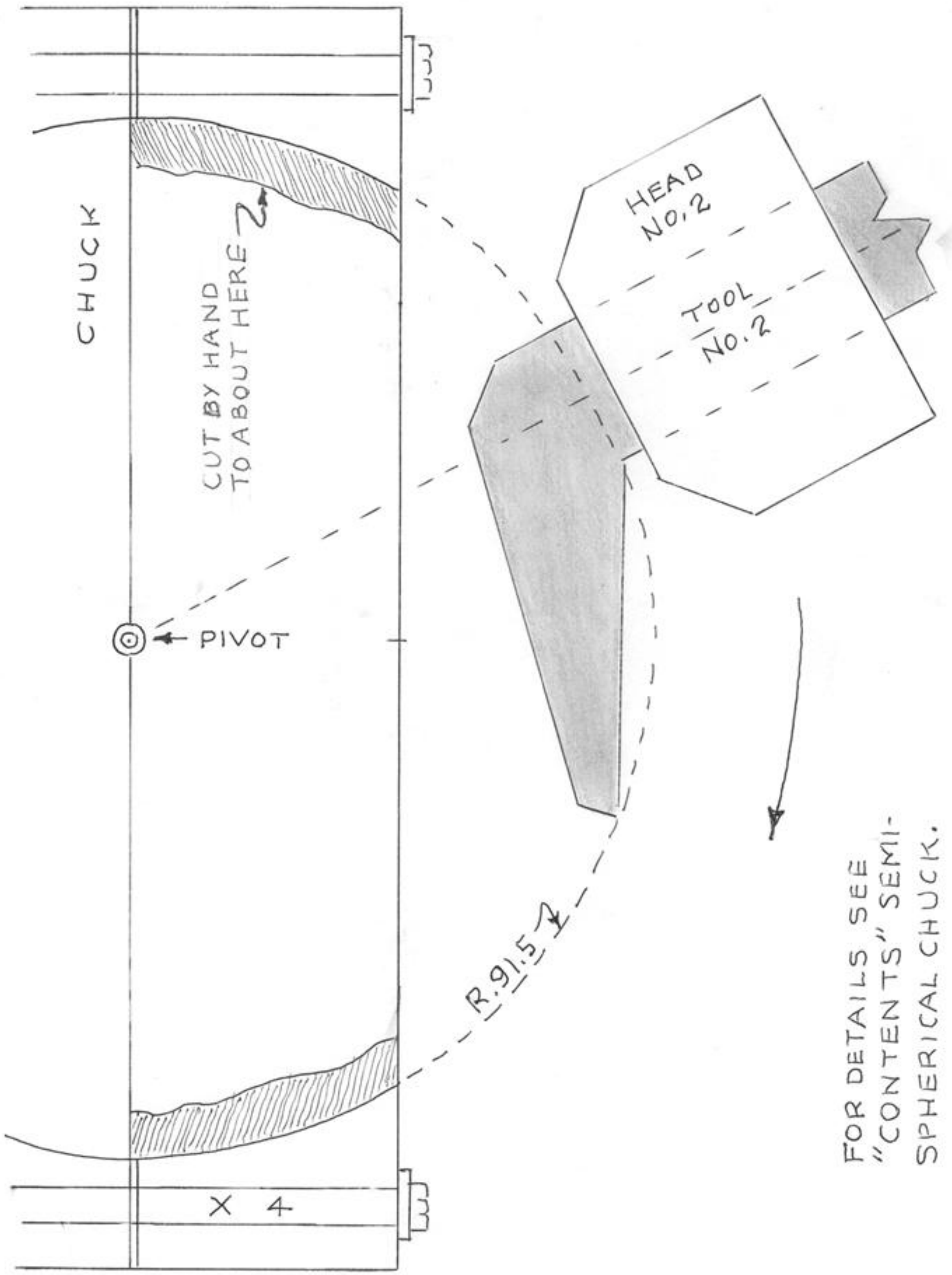
L-L (12 SPIKES) = 183.0 X 0.5257 = 96.2
S-S (20 SPIKES) = 183.0 X 0.3568 = 65.3
L-S (20/12 SPIKES = 183.0 X 0.3204 = 58.6

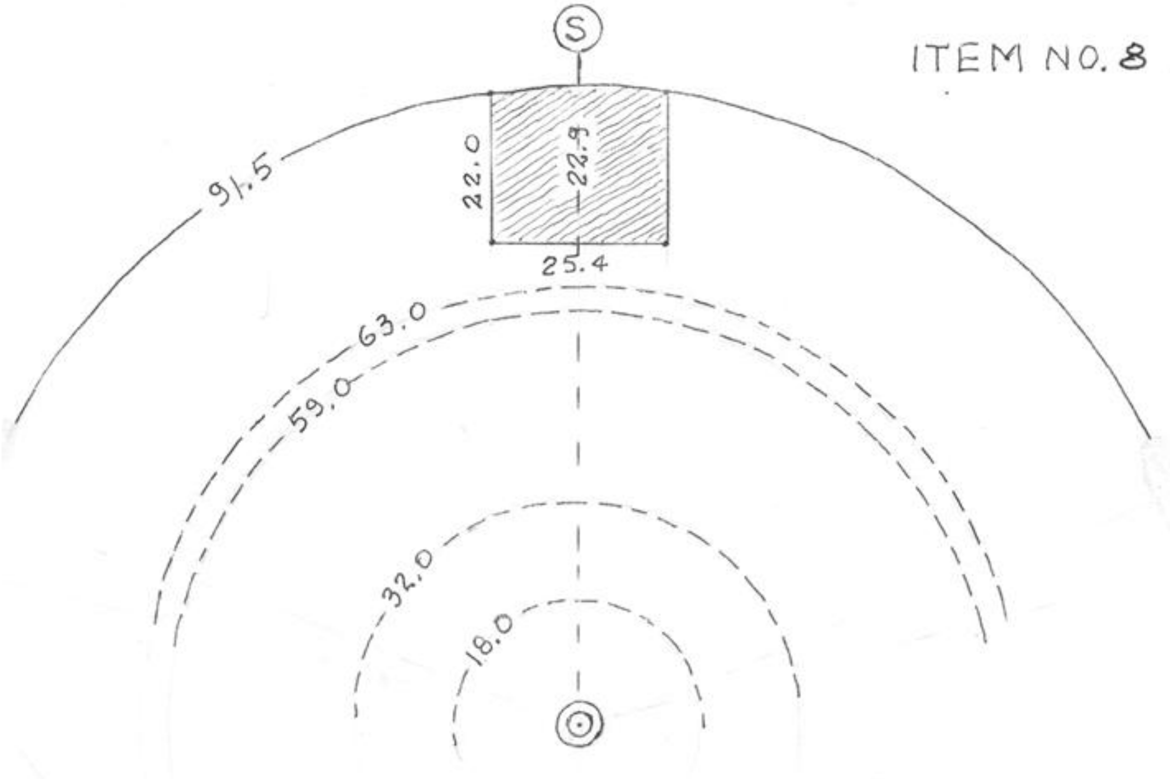

ITEM NO.2
CROSS-SECTION
45.0
CHUCK RING
110.0
CHUCK
105,0
91,5
R.91,5
X 4

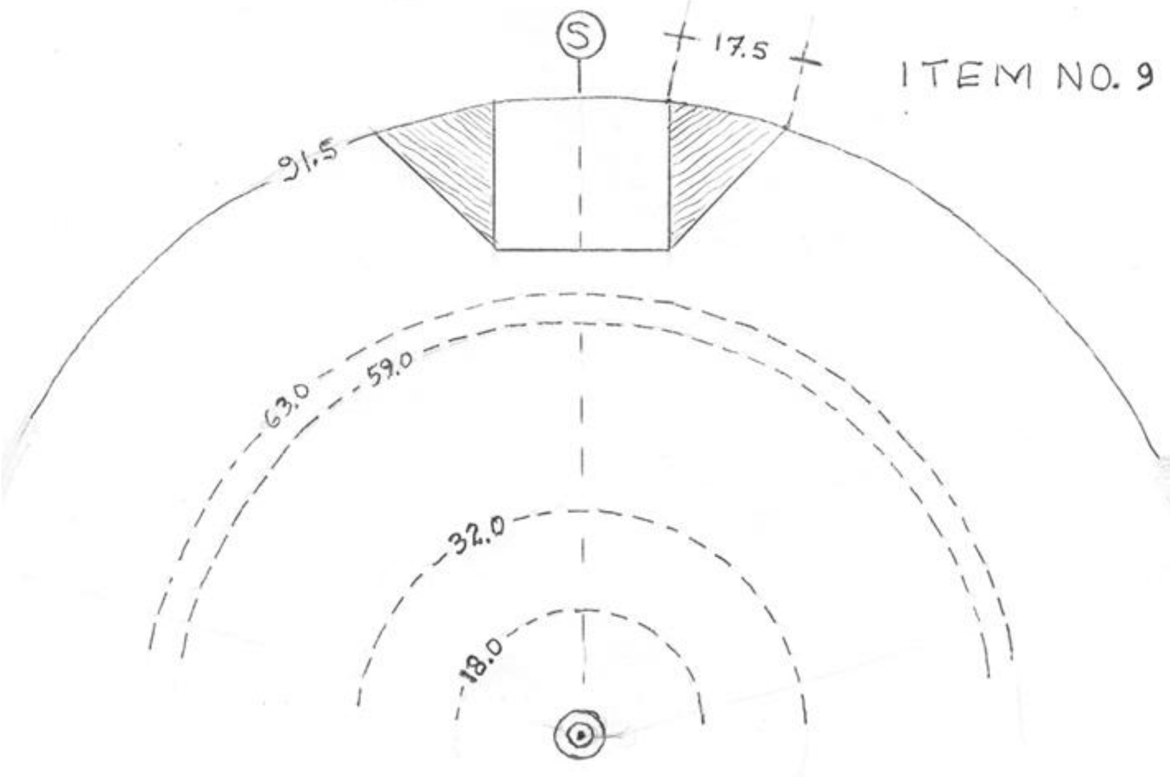
ITEM NO.3 ~CHUCK~

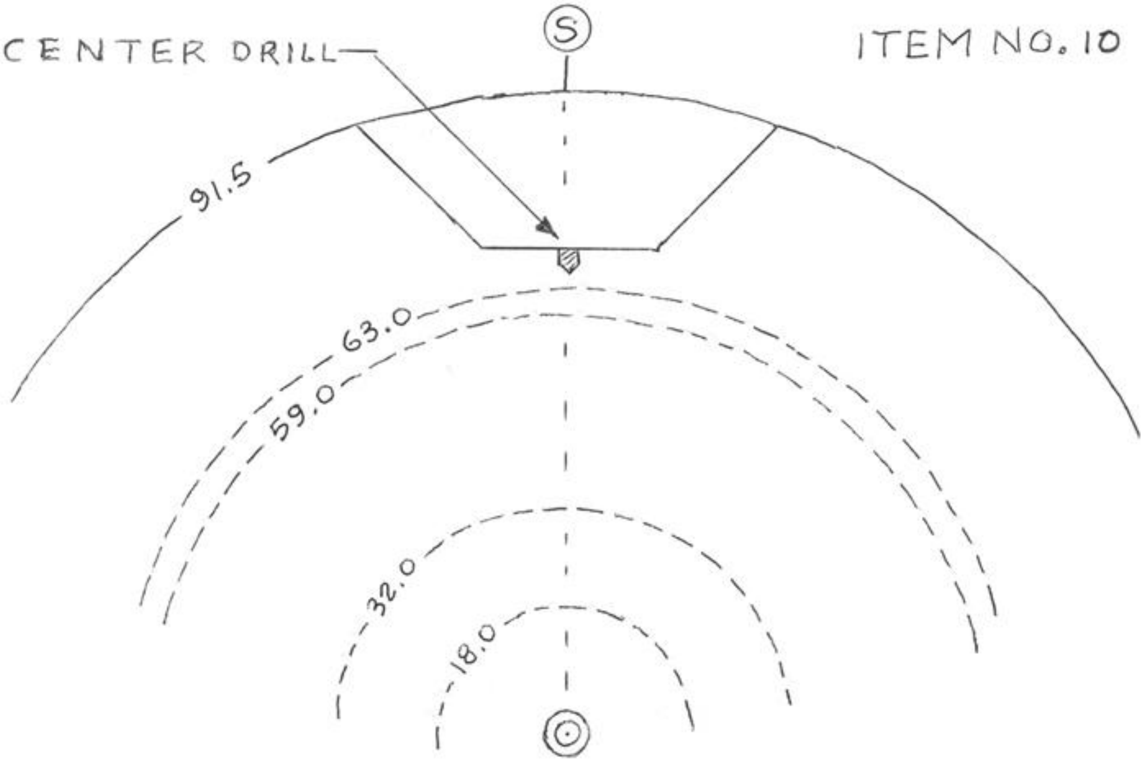


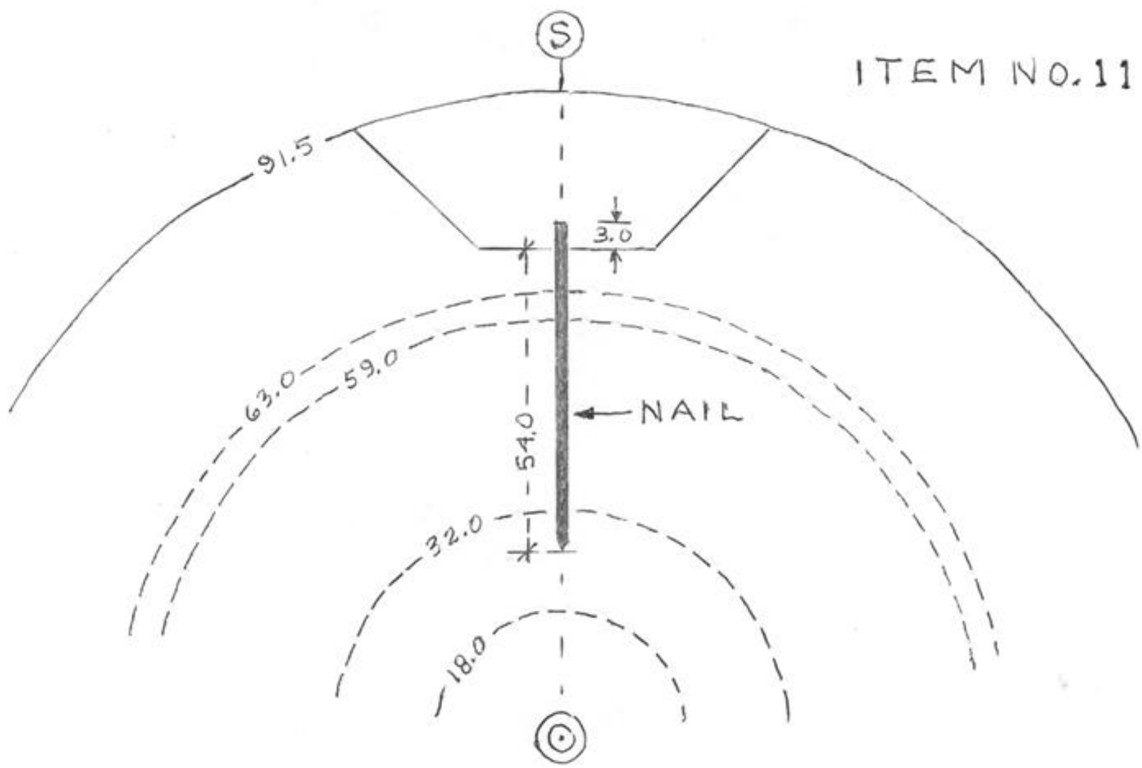
ITEM NO. 4 ~ CHUCK RING ~

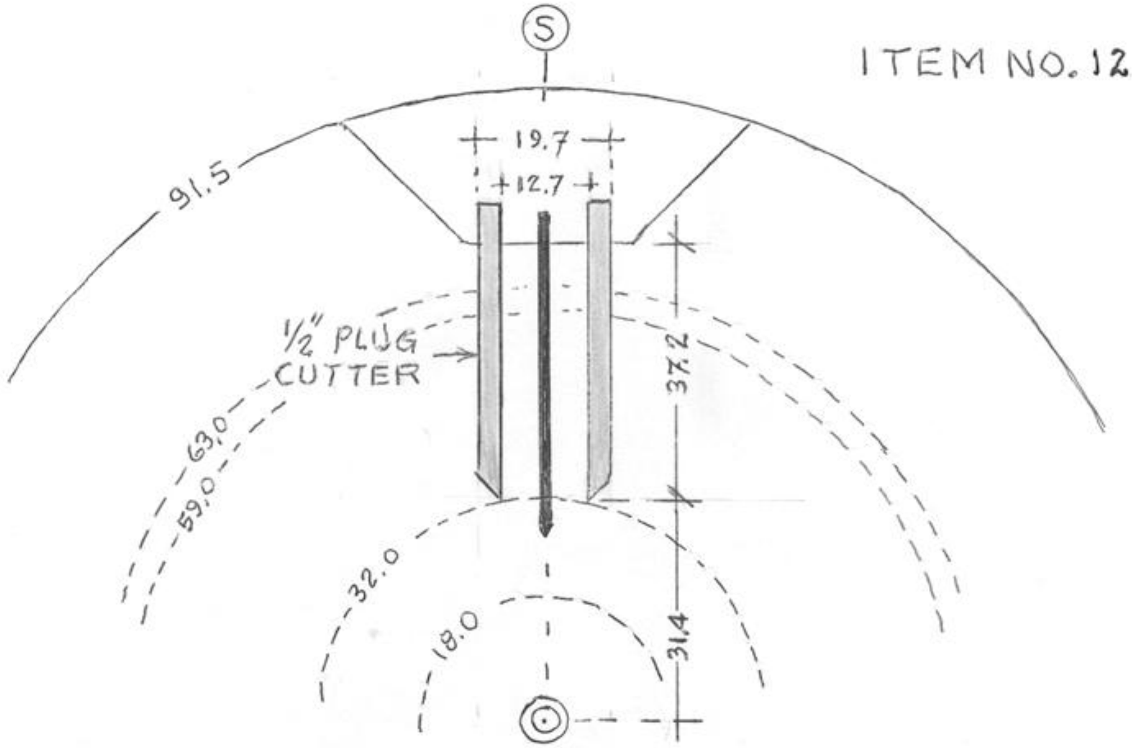


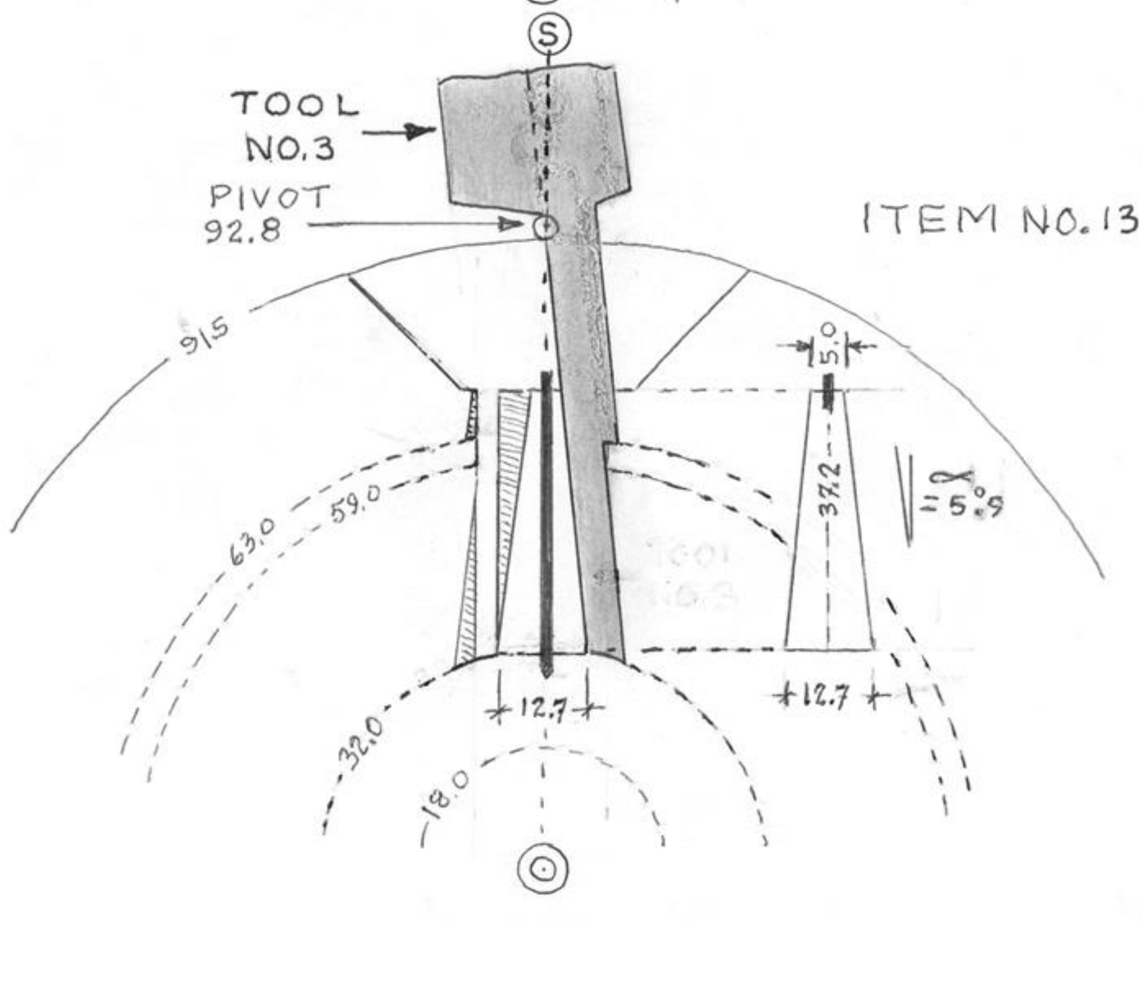

S
ITEM NO. 8
91.5
22.0
22.9
25.4
63.0
59.0
32.0
18.0


S
17.5
ITEM NO. 9
91.5
63.0
59.0
32.0
18.0

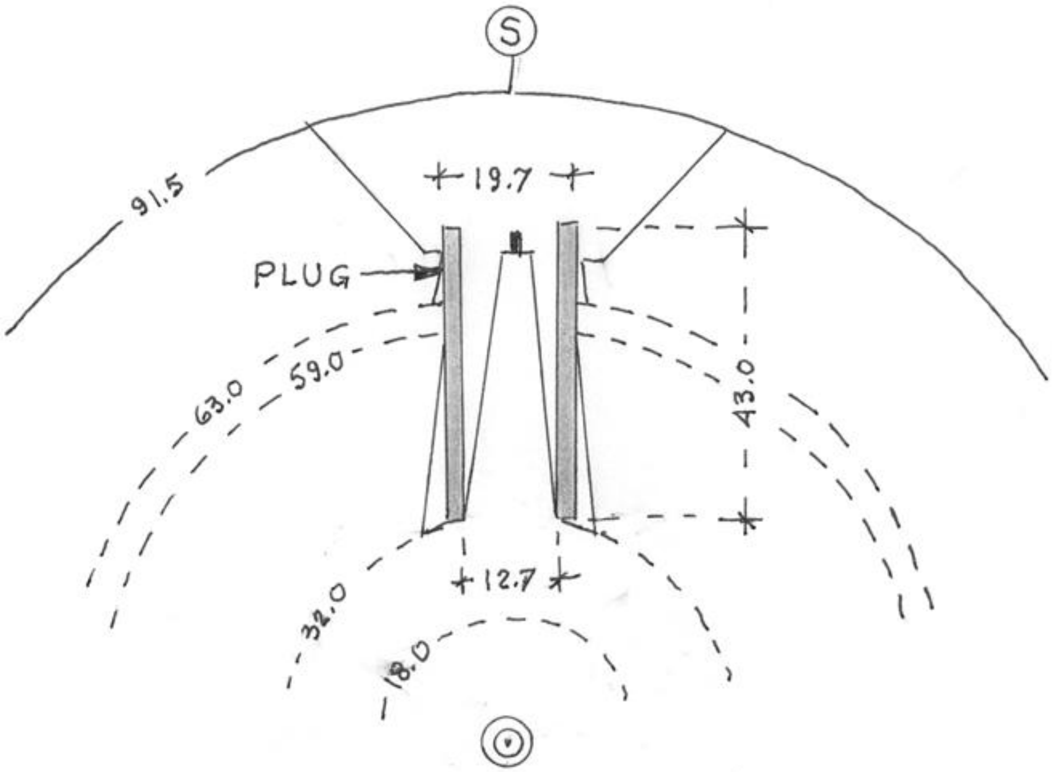

CENTER DRILL
ITEM NO. 10
91.5
63.0
59.0
32.0
18.0


ITEM NO. 11
91.5
3.0
63.0
59.0
54.0
NAIL
32.0
18.0


ITEM NO.12
19.7
12.7
91.5
1/2" PLUG CUTTER
37.2
63.0
59.0
32.0
18.0
31.4


TOOL NO.3
PIVOT 92.8
ITEM NO.13
91.5
5.0
37.2
α = 5.9
63.0
59.0
12.7
12.7
32.0
18.0

ITEM NO. 14

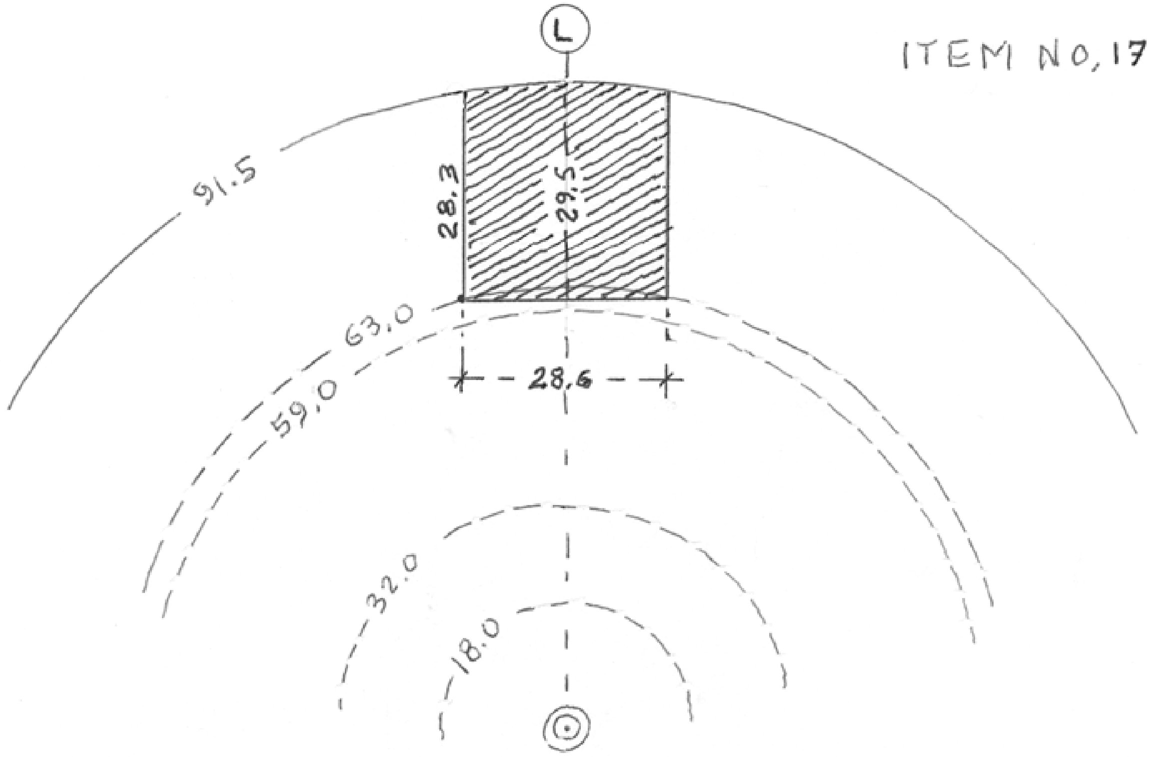


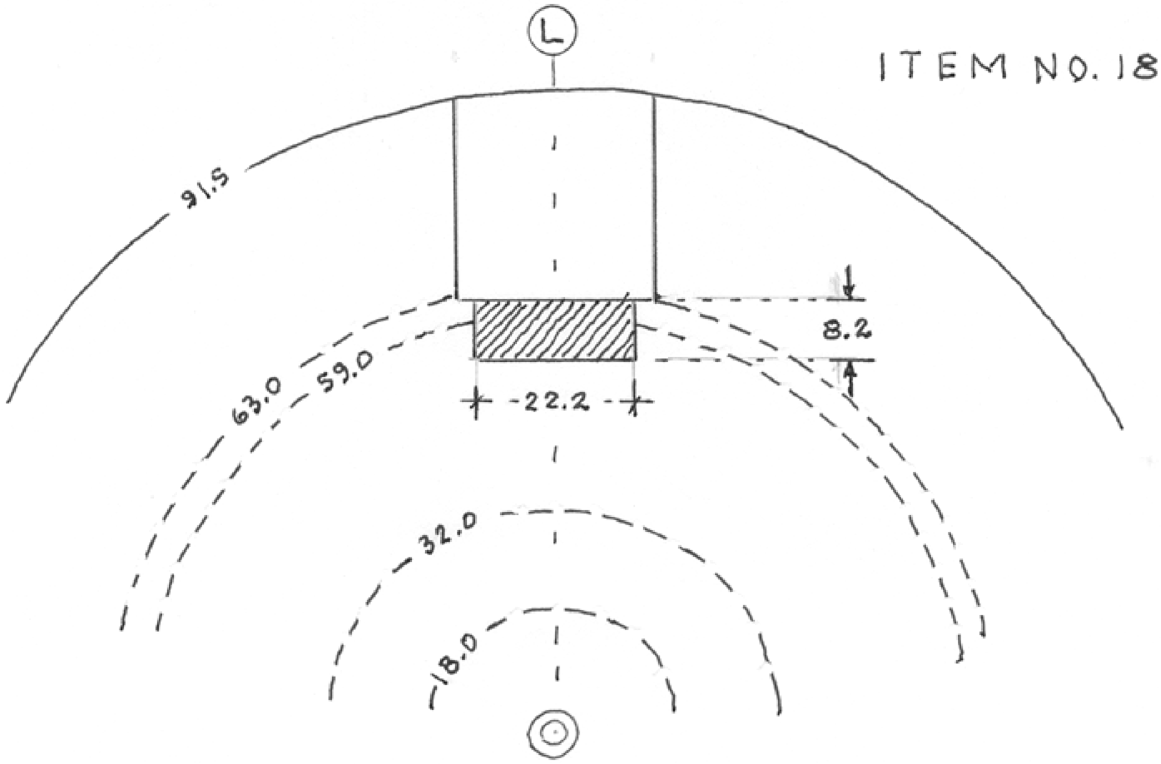
~ Sequence of operations ~

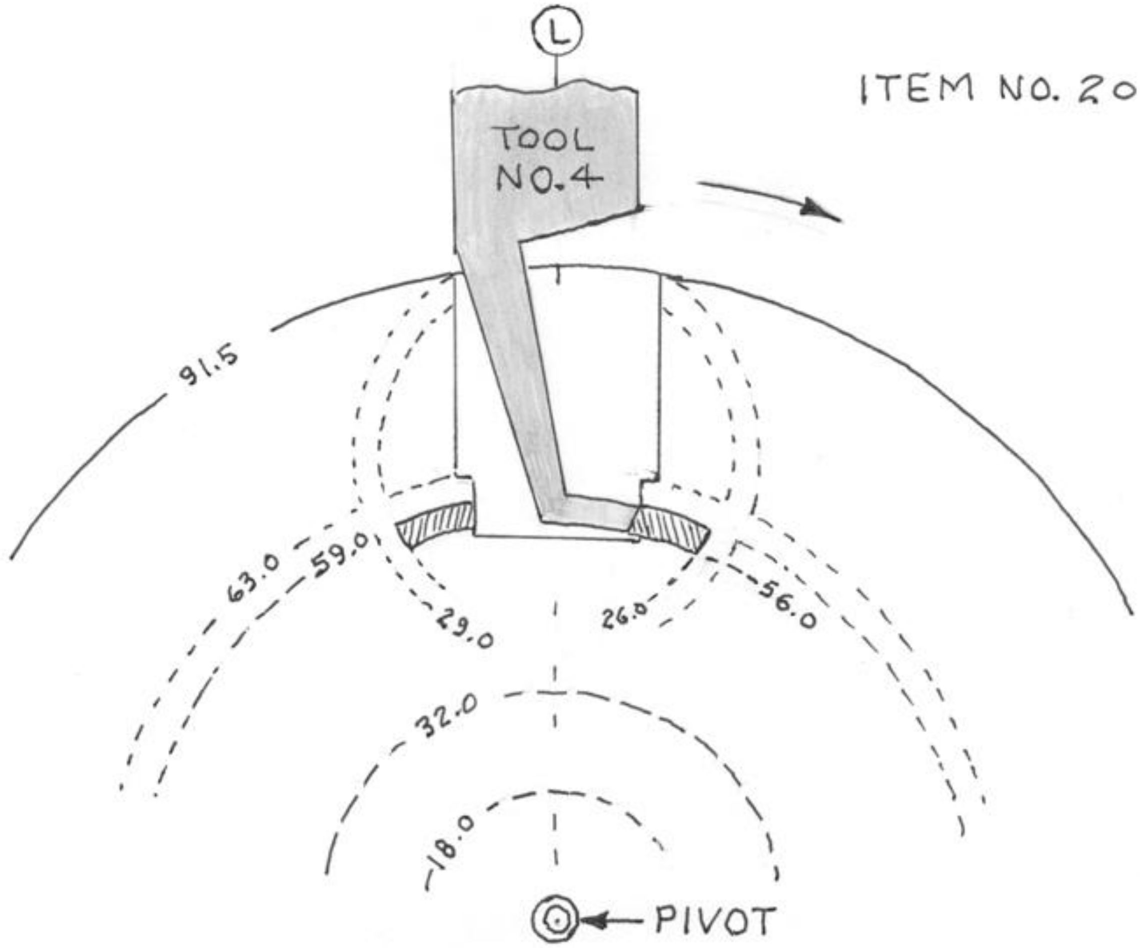
"L" (12 spikes Star)

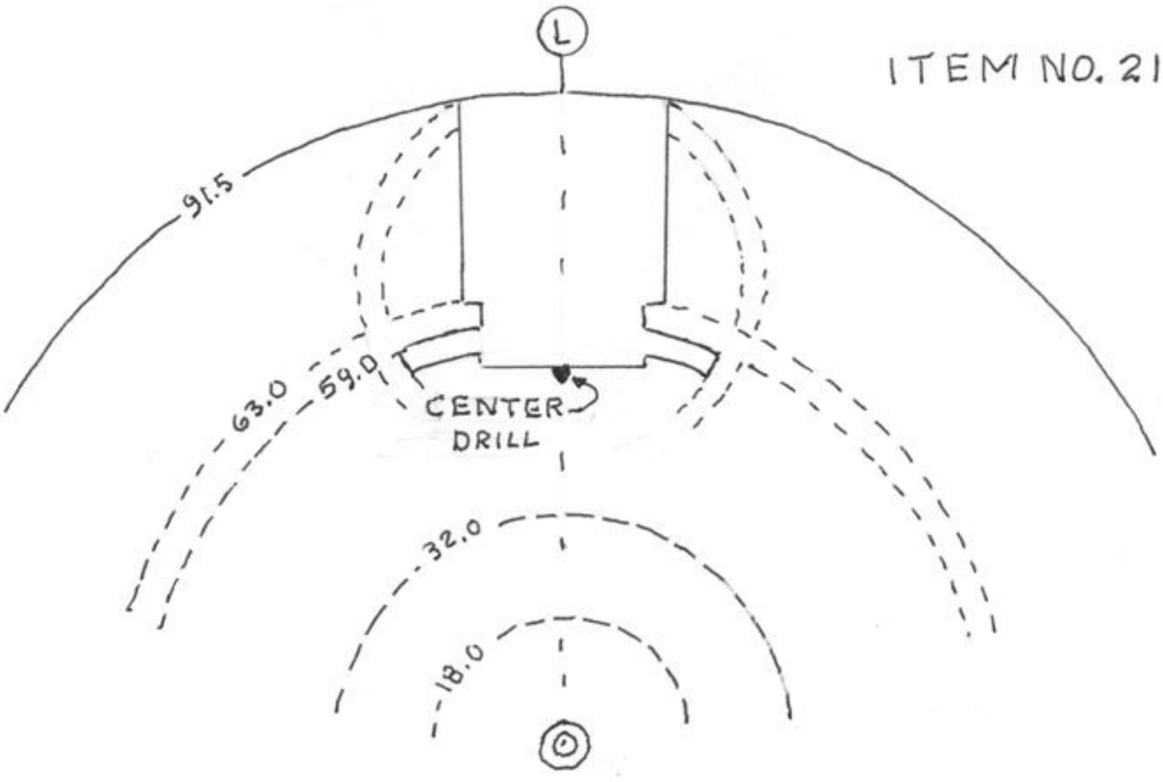
Item

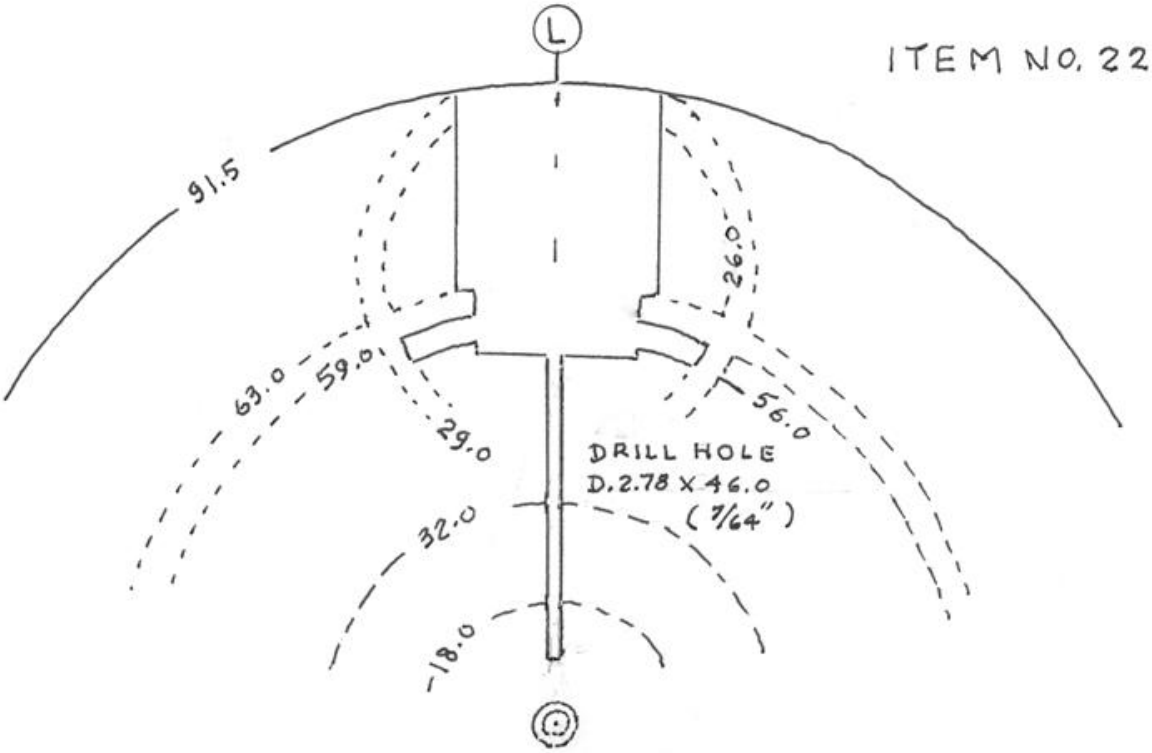
35. Set sphere in chuck, align an Ⓛ point and set chuck ring
36. Cut hole Ø28.6 depth 29.5 at center
37. Cut hole Ø22.2 depth 8.2
38. Make tools N°4 to 13 included
39. Use tool N°4
40. Mark with center drill
41. Drill hole Ø2.78 depth 46.0
42. Set metal rod
43. Use plug cutter
44. Use tool N°5
45. Use tool N°6
46. Use tool N°7
47. Use tool N°8
48. Use tools N°9 and 10
49. Use tools N°11 and 12
50. Use tool N°13
51. Set double plugs
52. Repeat items N° 20 to 32 included till all 12 Ⓛ points are done

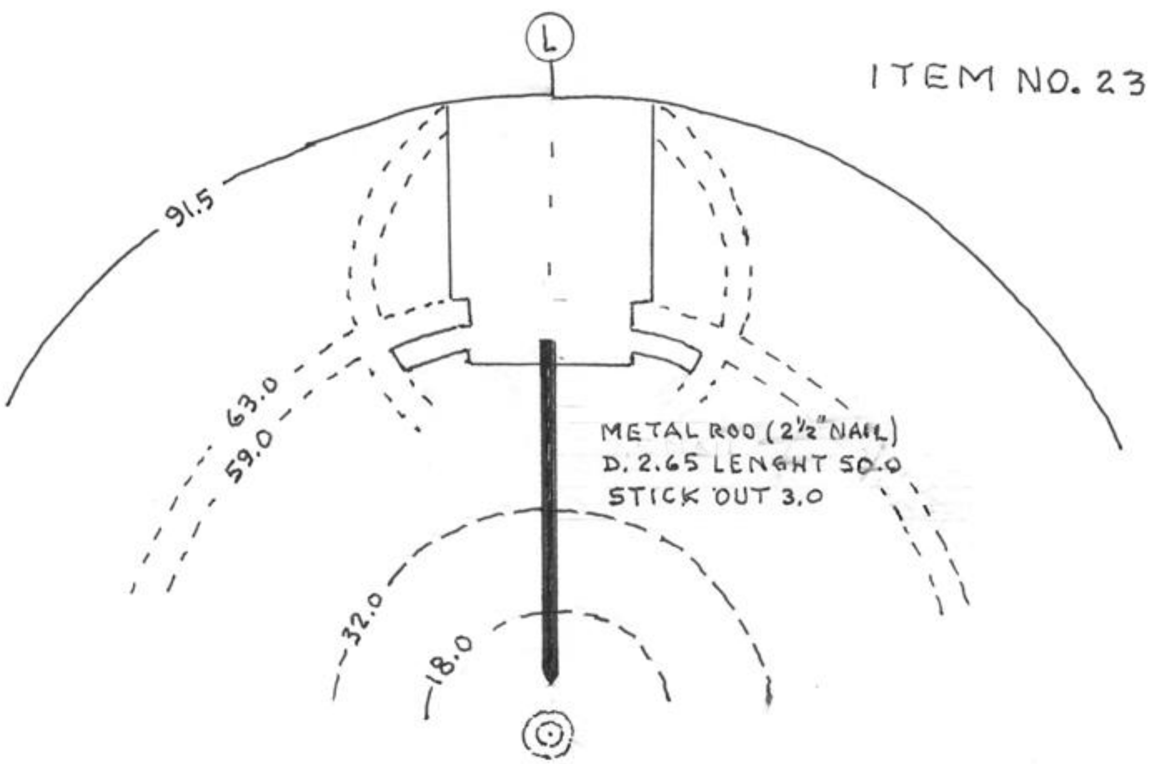

ITEM NO,17
91.5
28.3
29.5
63.0
59.0
28.6
32.0
18.0


ITEM NO. 18
91.5
8.2
63.0
59.0
22.2
32.0
18.0

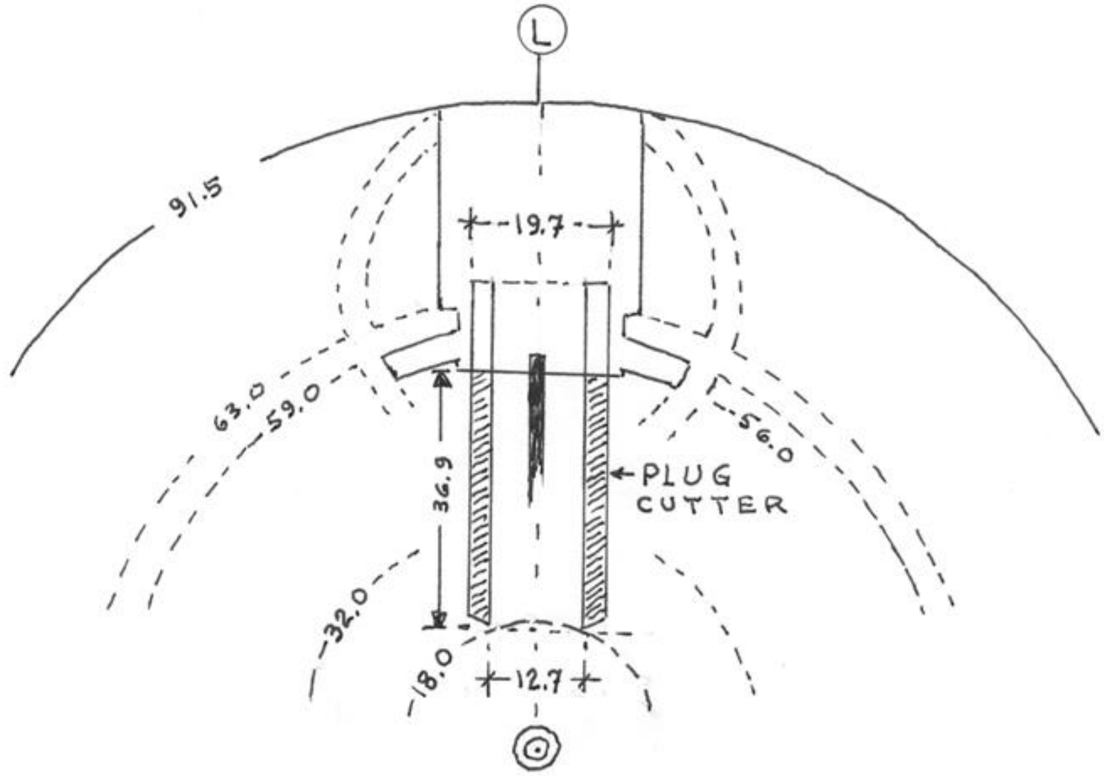

ITEM NO. 20
L
TOOL
NO.4
91.5
63.0
59.0
29.0
26.0
56.0
32.0
18.0
PIVOT


ITEM NO. 21
L
91.5
63.0
59.0
CENTER
DRILL
32.0
18.0

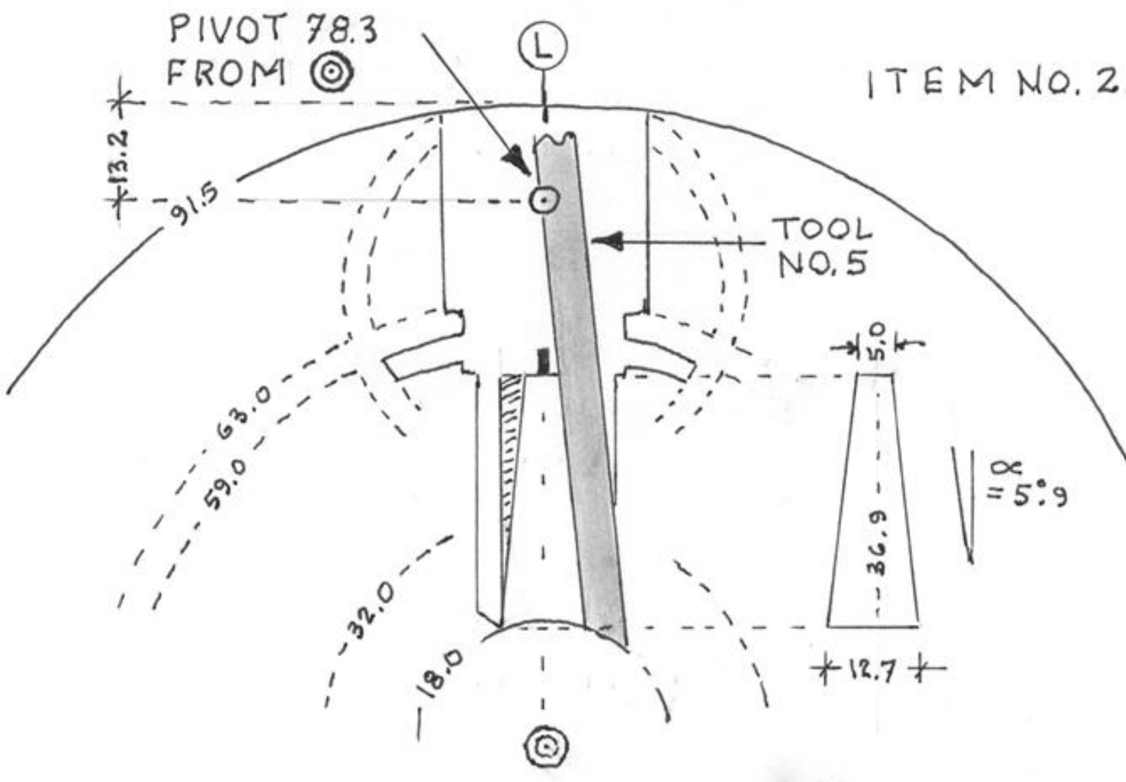

L
ITEM NO. 22
91.5
26.0
63.0
59.0
29.0
56.0
DRILL HOLE
D. 2.78 X 46.0
(7/64")
32.0
18.0

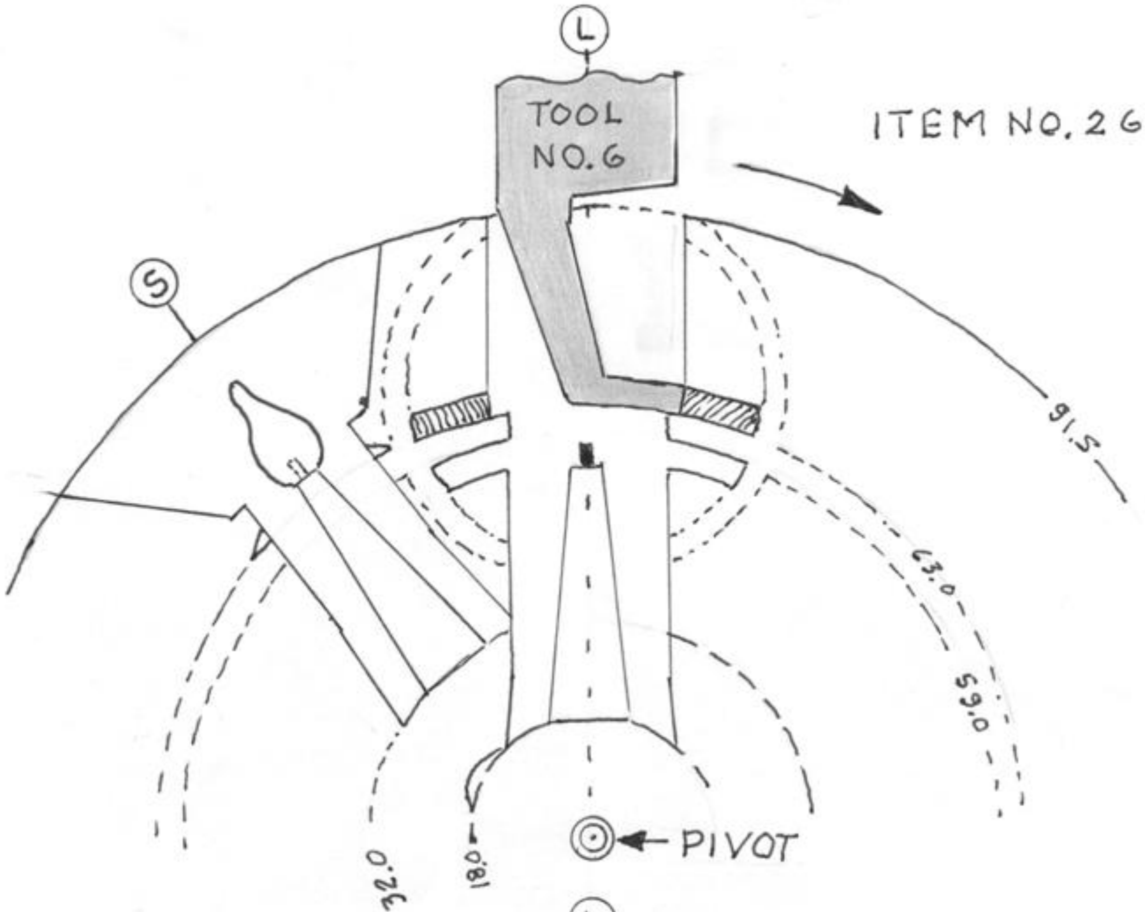

L
ITEM NO. 23
91.5
63.0
59.0
METAL ROD (2½" NAIL)
D. 2.65 LENGHT 50.0
STICK OUT 3.0
32.0
18.0

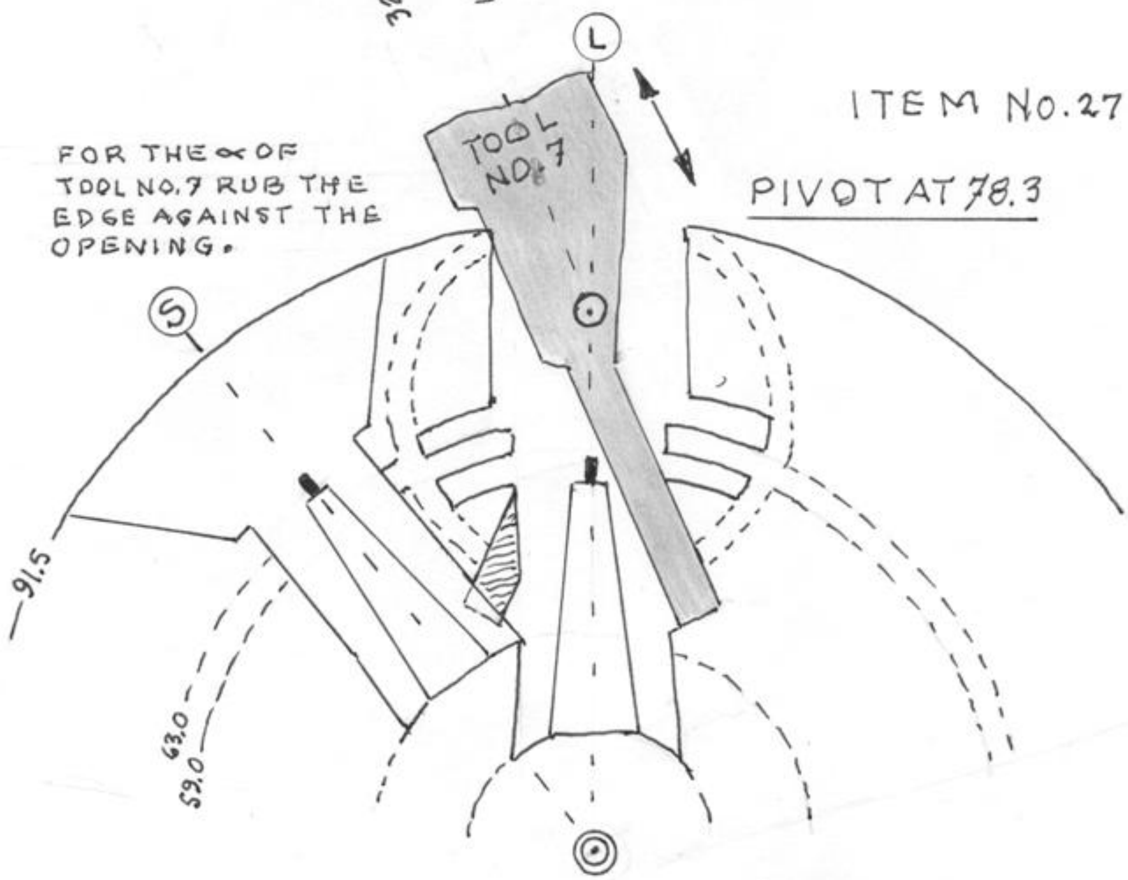
ITEM NO. 24



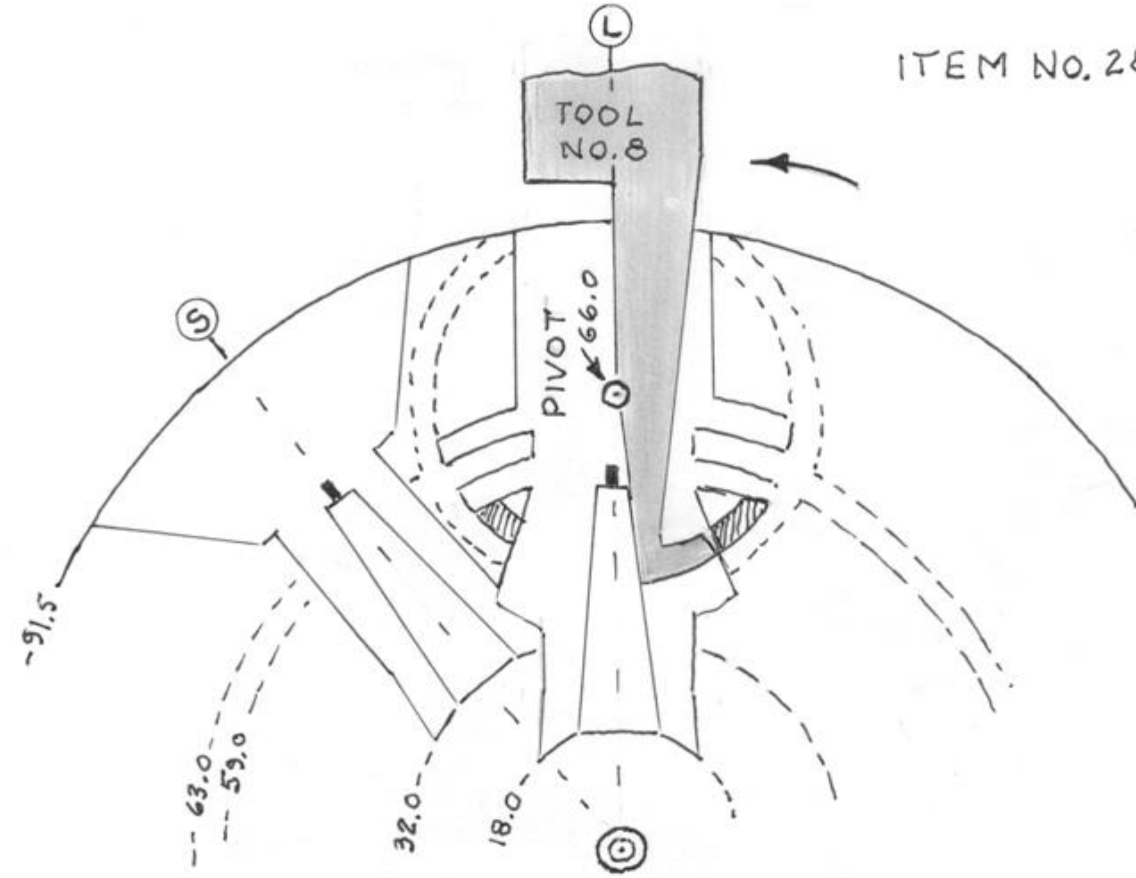
ITEM NO. 25



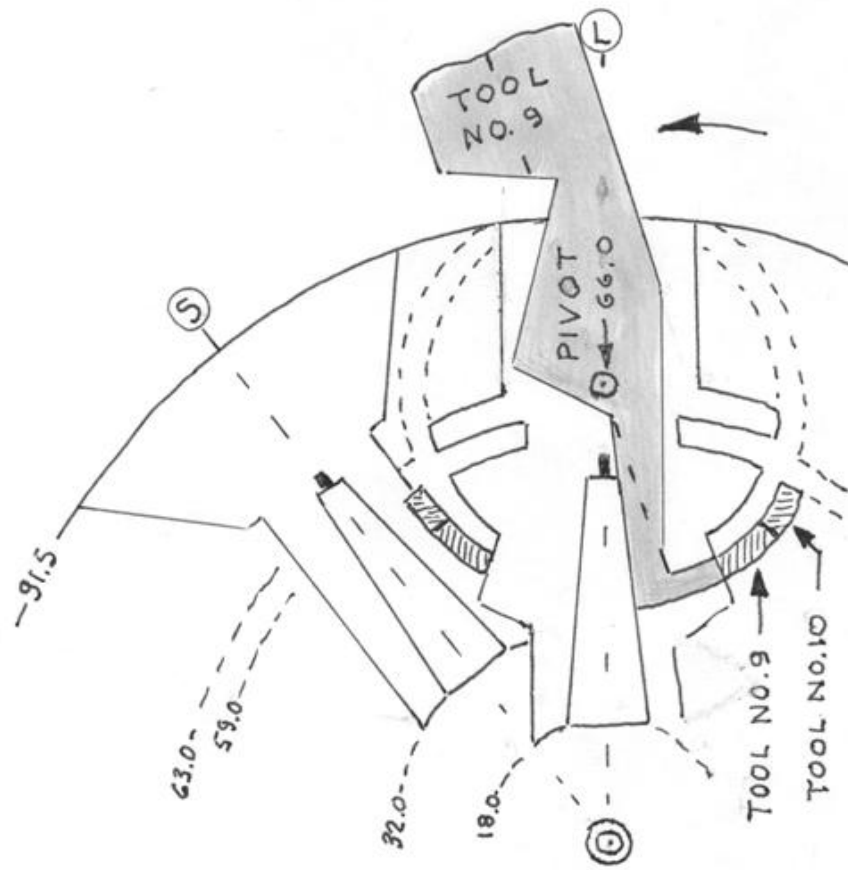

L
TOOL NO.6
ITEM NO. 26
S
91.5
63.0
59.0
32.0
18.0
PIVOT


L
ITEM NO.27
TOOL NO.7
FOR THE ∝ OF TOOL NO.7 RUB THE EDGE AGAINST THE OPENING.
PIVOT AT 78.3
S
91.5
63.0
59.0

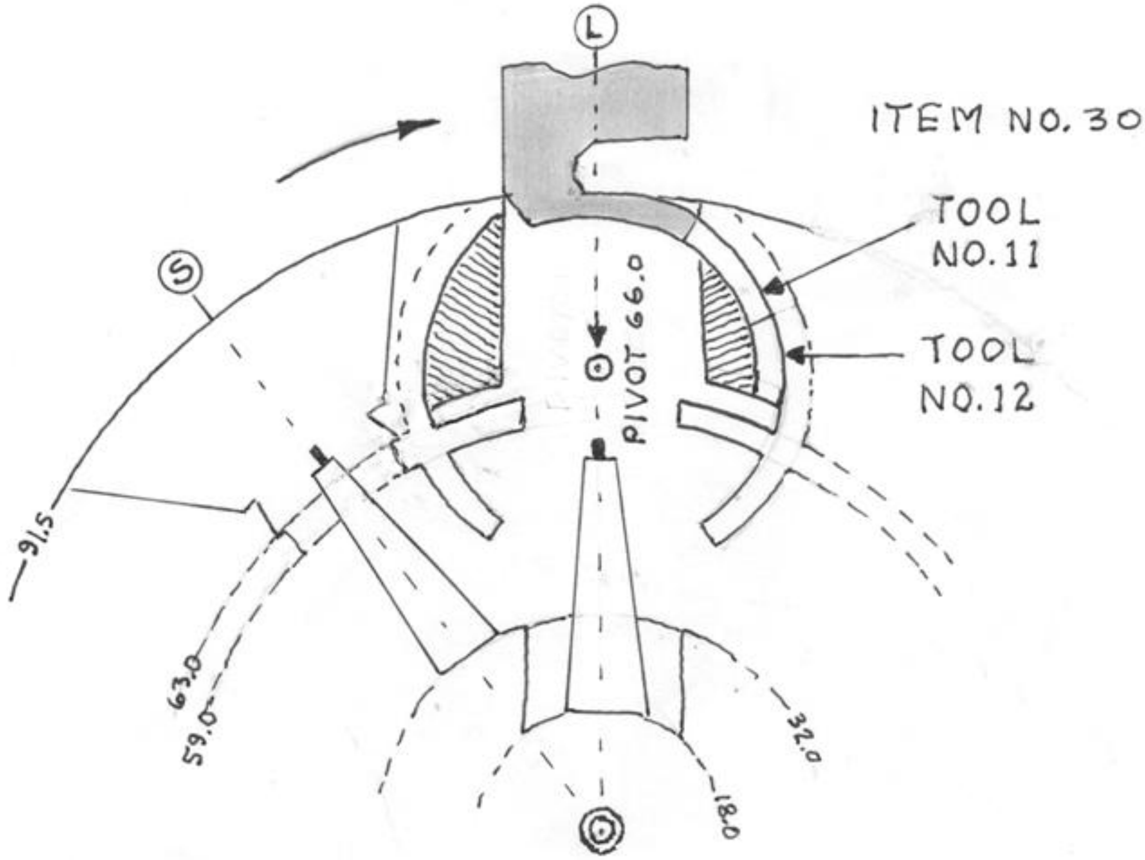
ITEM NO. 28



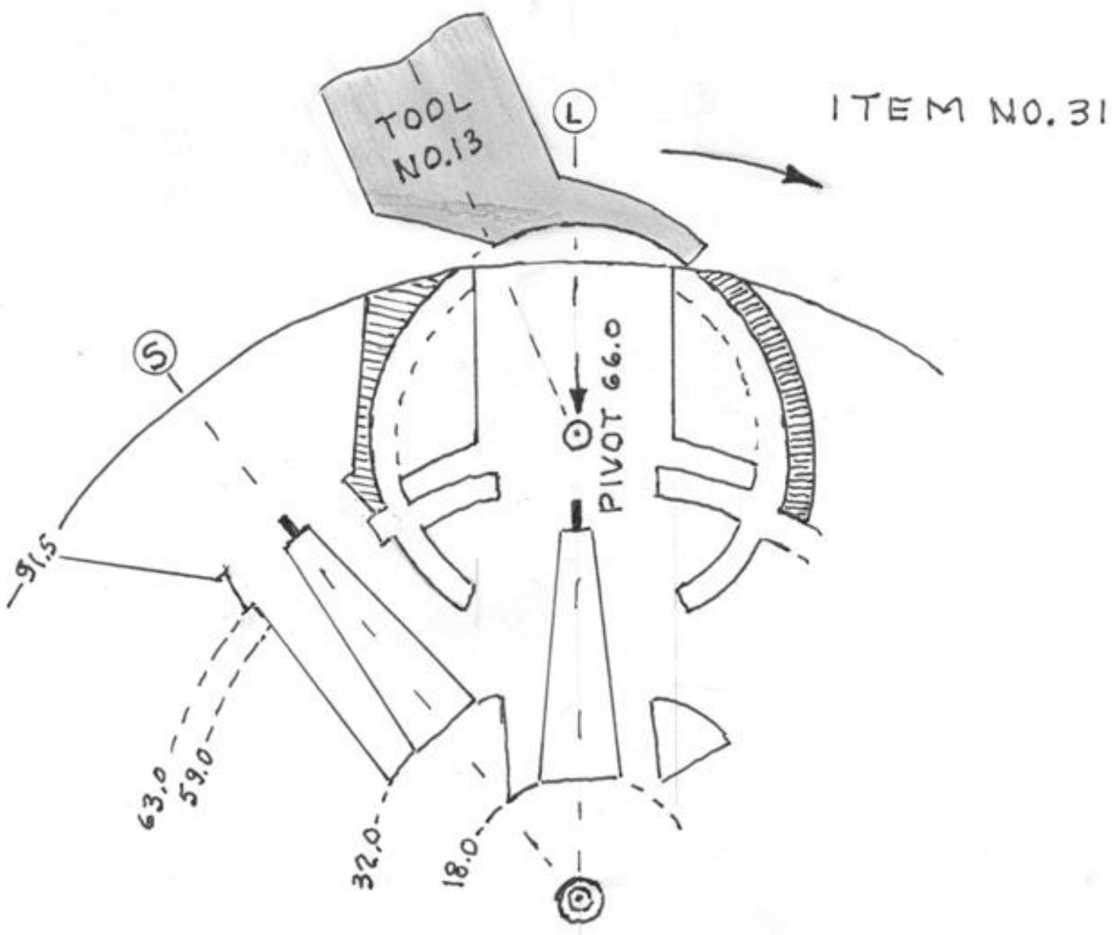
ITEM NO. 29



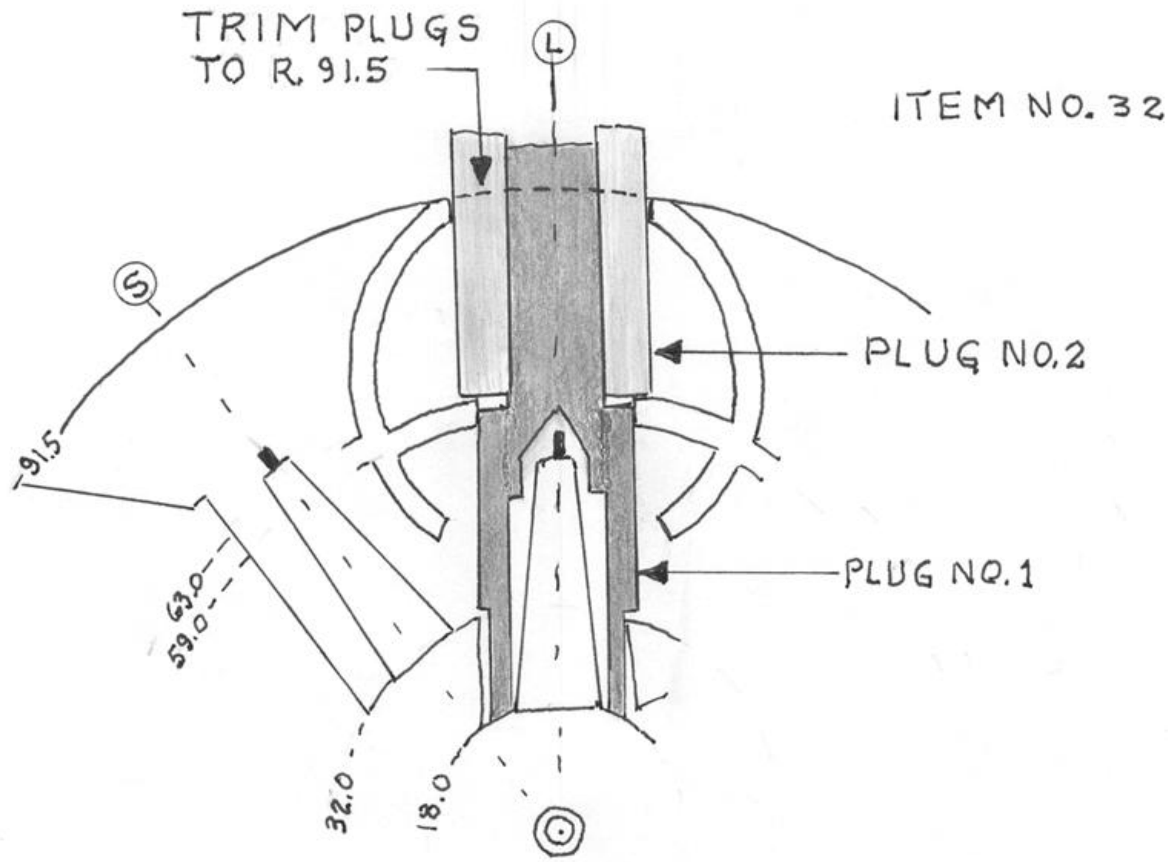
NOTE:
FOR TOOL NO. 10 REMOVE HEAD SO AS TO POSITION THE TOOL ON EDGE AND THEN TURN IT HORIZONTALY AND SET HEAD BACK.



ITEM NO. 30
TOOL NO. 11
TOOL NO. 12
L
S
PIVOT 66.0
91.5
63.0
59.0
32.0
18.0



ITEM NO. 31
TOOL NO. 13
L
S
PIVOT 66.0
91.5
63.0
59.0
32.0
18.0



TRIM PLUGS
TO R, 91.5
L
ITEM NO. 32
S
PLUG NO. 2
91.5
PLUG NO. 1
63.0
59.0
32.0
18.0

~ *Sequence of operations* ~

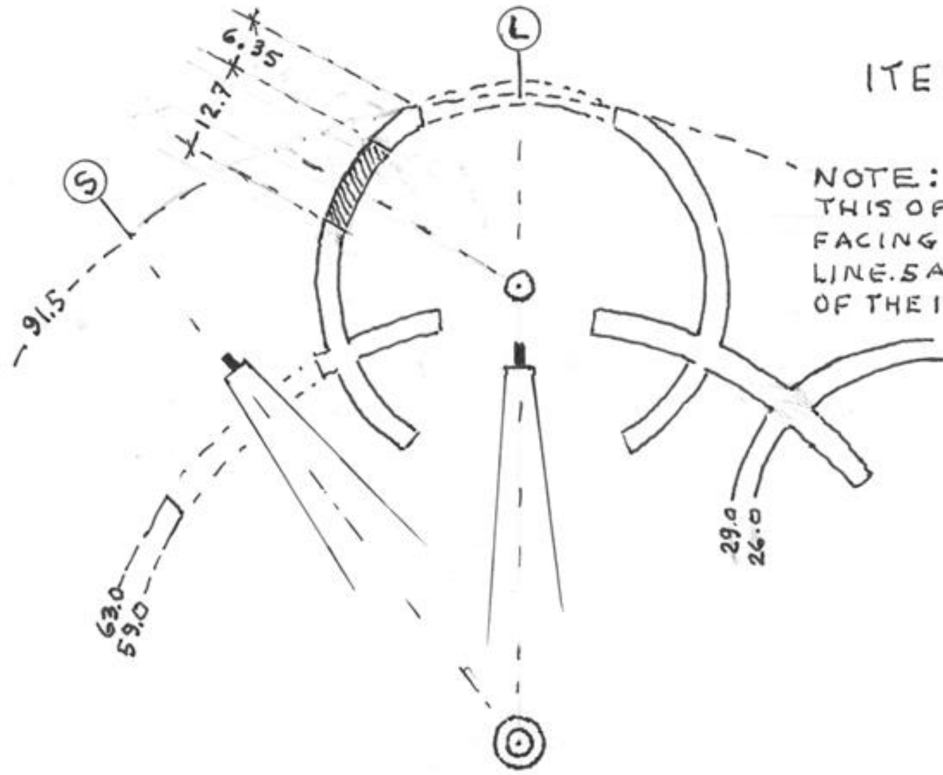
(Interlocking the spheres)

Remove plugs as necessary

Item

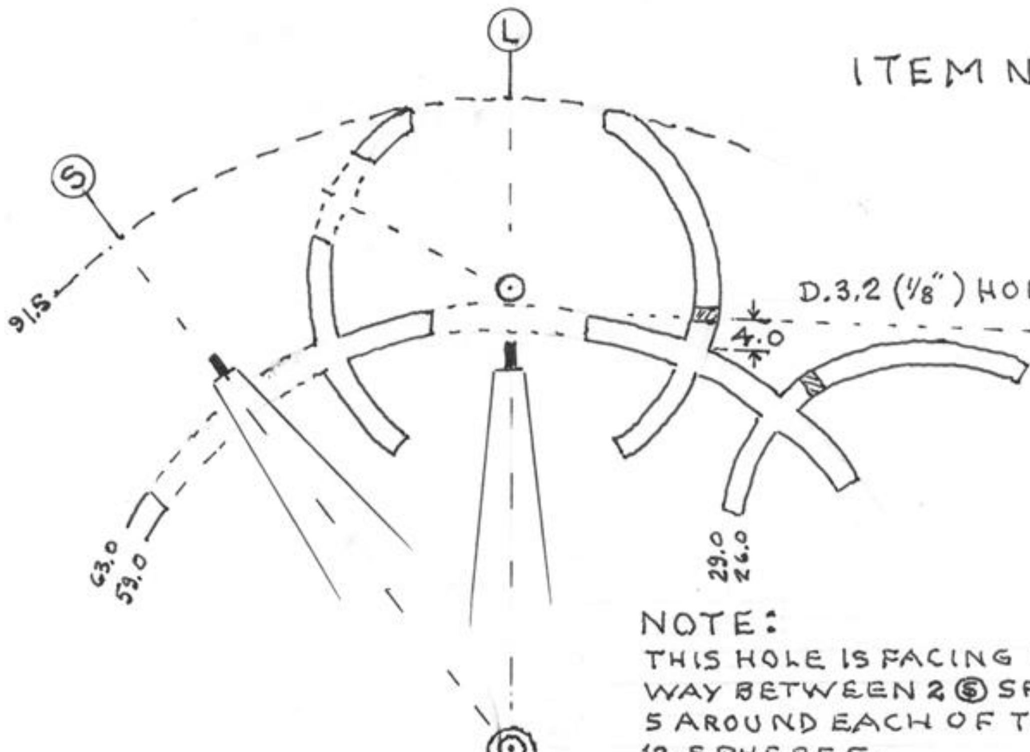
53. Mark R.29.0 sphere, drill Ø12.7 (1/2”) hole (5 per sphere), repeat for the 12 spheres
54. Mark R.29.0 sphere, drill Ø3.2 (1/8”) hole (5 per sphere), repeat for the 12 spheres
55. With tool N°14 cut part of Ø25.4 opening above R.63.0 sphere only, leaving wood around pivoting 3.2 hole to be re-used for item N°50 (5 per sphere x 12 spheres). See item N°50 for tool N°14.
56. Make wood gage to mark Ø38.0 opening (20) to be cut with tool N°13
57. With tool N°15 enlarge Ø19.7 hole to Ø38.0 passing behind into 3 Ø29.0 spheres, repeat for the 20 openings. See item N°50 for tool N°15.
58. With tool N14 cut the lower part of the Ø25.4 opening passing through Ø38.0 opening on Ø63.0 sphere, repeat for all 20 openings
59. Remove all the eye shape wood inside both small and large spheres left there by tools N°12 and 13.

ITEM NO. 34



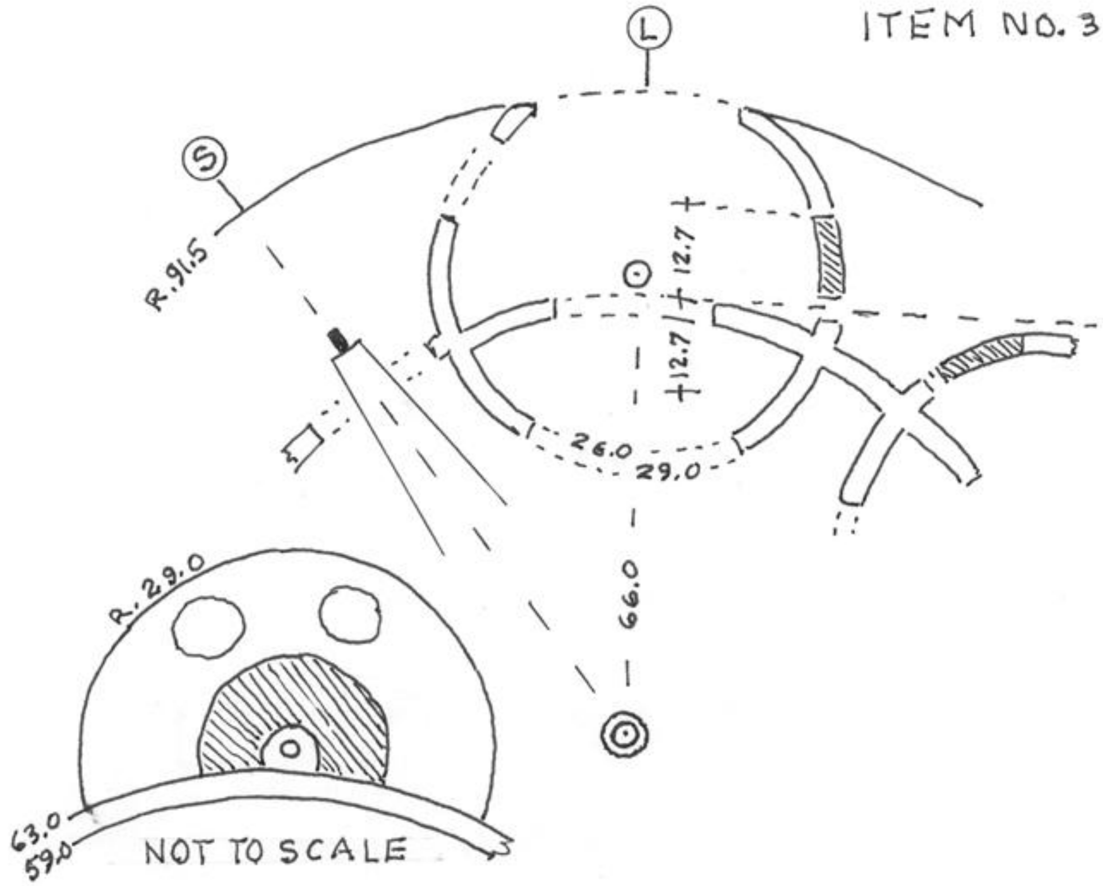
NOTE:
THIS OPENING IS FACING SPIKE (S) LINE. 5 AROUND EACH OF THE 12 SPHERES.

ITEM NO. 35

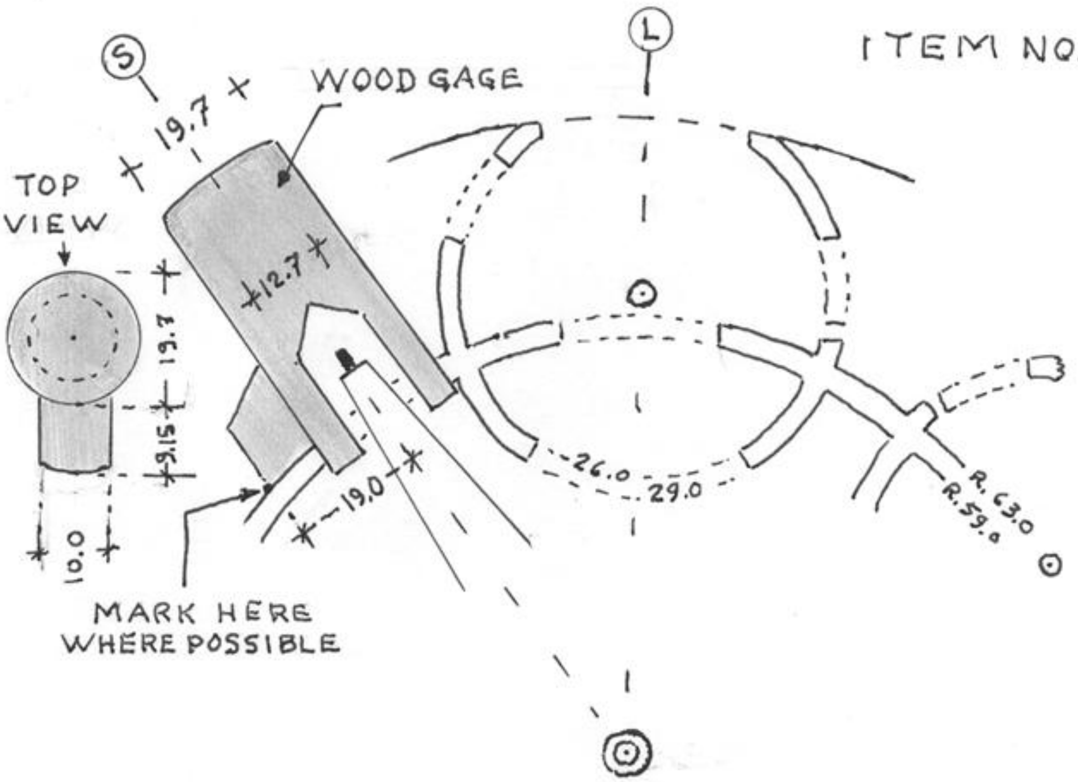


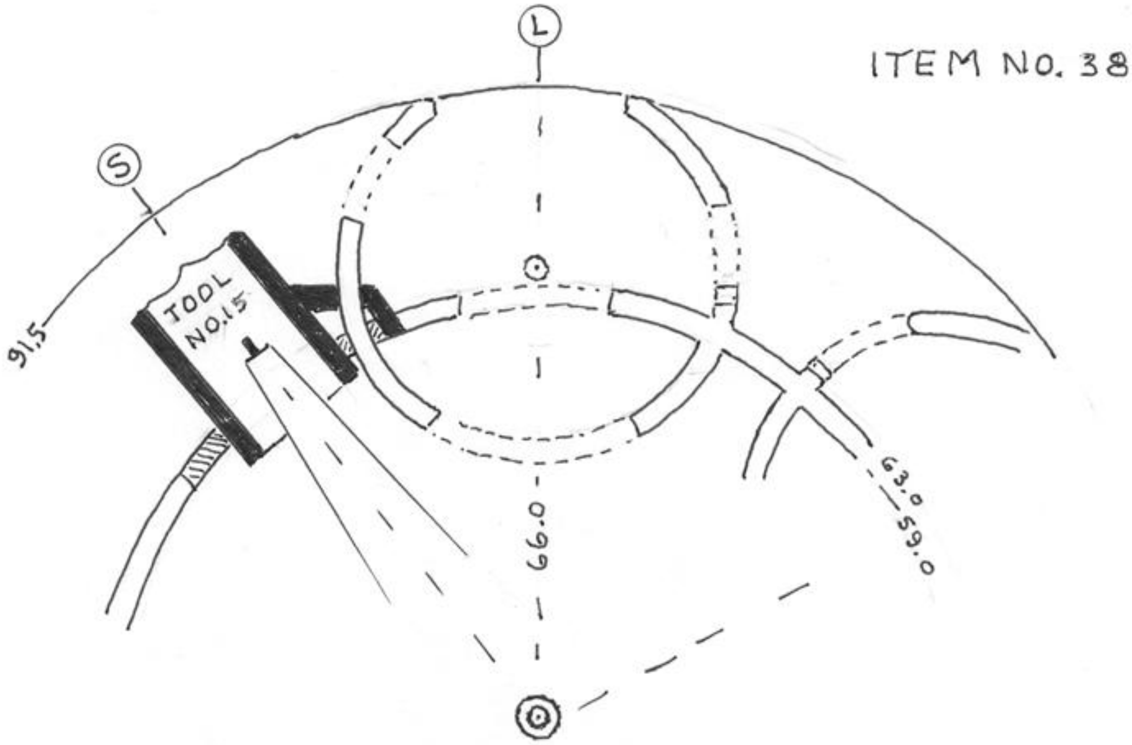
NOTE:
THIS HOLE IS FACING HALF-WAY BETWEEN 2 (S) SPIKES 5 AROUND EACH OF THE 12 SPHERES.

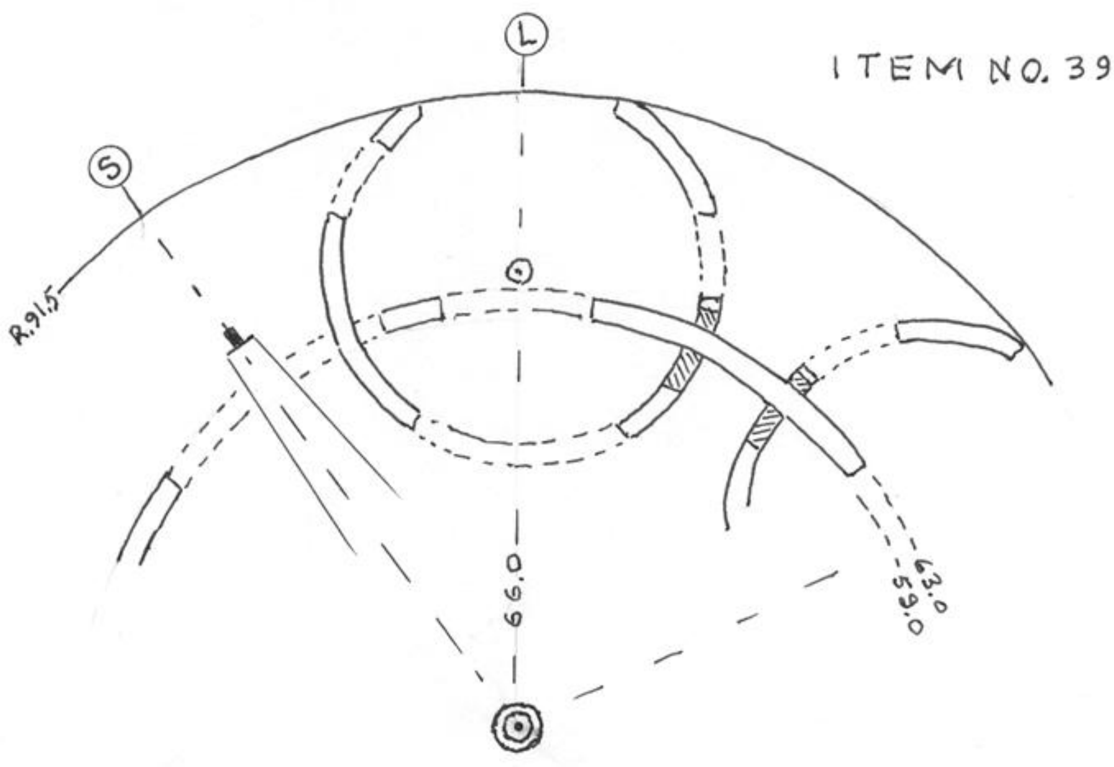
ITEM NO. 36

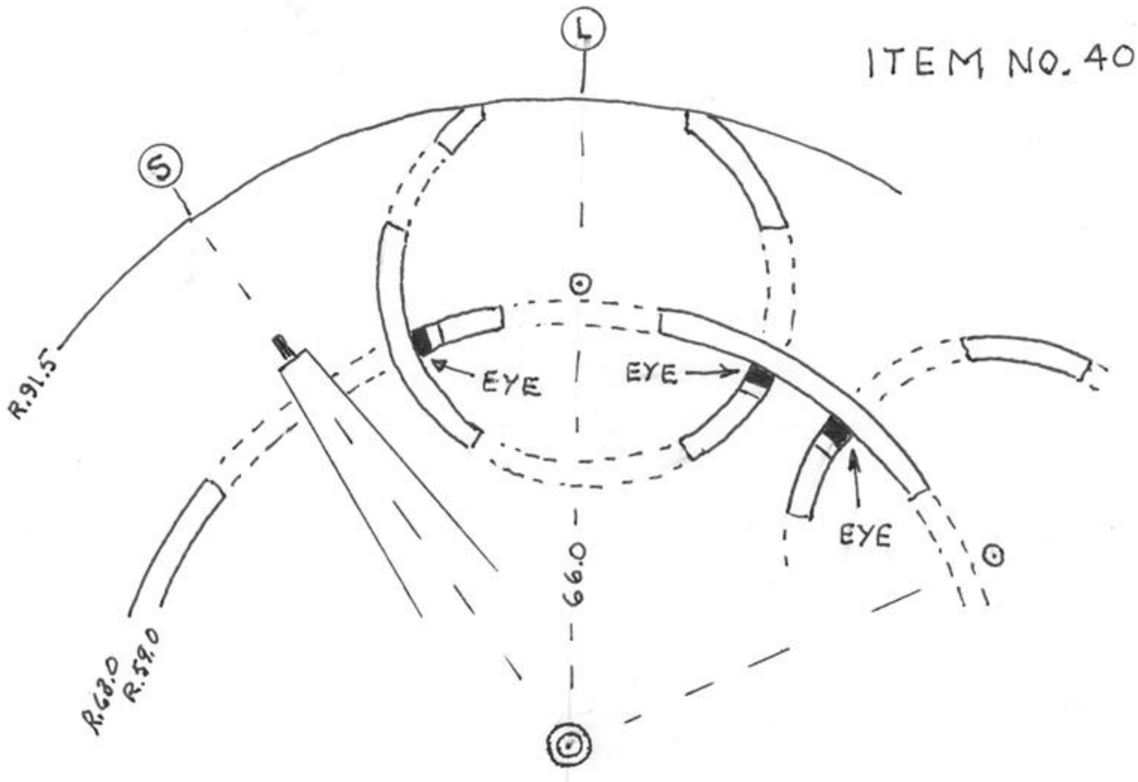


ITEM NO. 37




ITEM NO. 38
L
S
TOOL NO.15
91.5
66.0
63.0
59.0


ITEM NO. 39
L
S
R.91.5
66.0
63.0
59.0



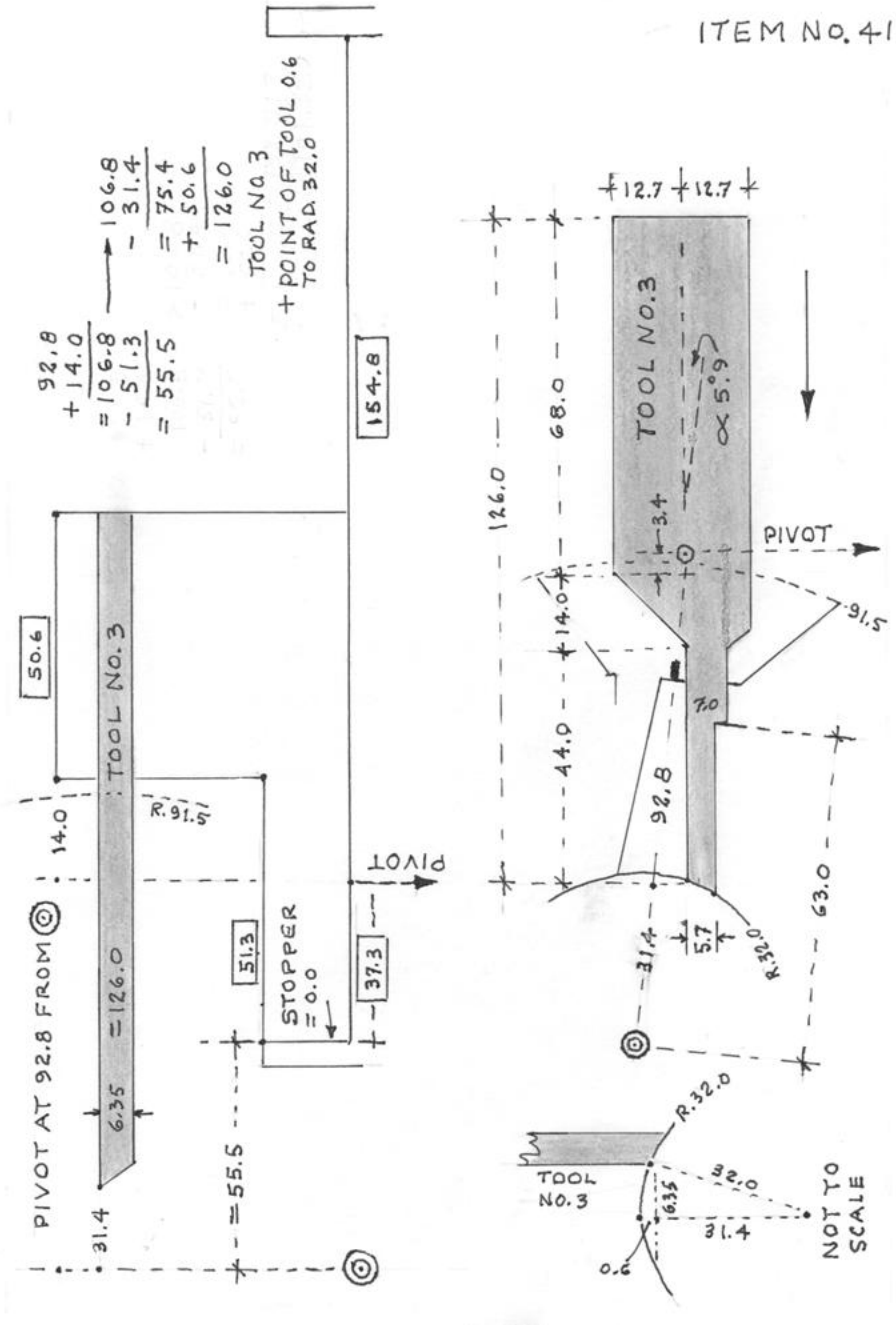
L
ITEM NO. 40
S
R.91.5
EYE
EYE
EYE
66.0
R.68.0
R.59.0

Details of tools N° 1 to 15

11- Form and dimensions.
12- Position of tool in sphere jig .
13- Position of sphere jig versus R.91.5 sphere.
14- Movement or rotation of sphere jig by arrow.
15- Note 1 : top edge of cutting end of tool to be at lathe center height.
16- Note 2 : except for the cutting end, the width of the tool inside the turning should be relieved so as not to rub on each side.
17- Note 3 : these tools are made for <u>my</u> sphere jig and for that <u>particular</u> turning only.
18- All distances in a rectangle are fixed dimensions of the sphere jig.
19- These drawings are rough hand drawings to approximate scale; they have to be re-drawn <u>very accurately</u> on the simulation plate with the appropriate part of the cross-section.
20- For the rough cutting of the tools use the <u>dimensions</u> of the rough drawings, do not trace over.

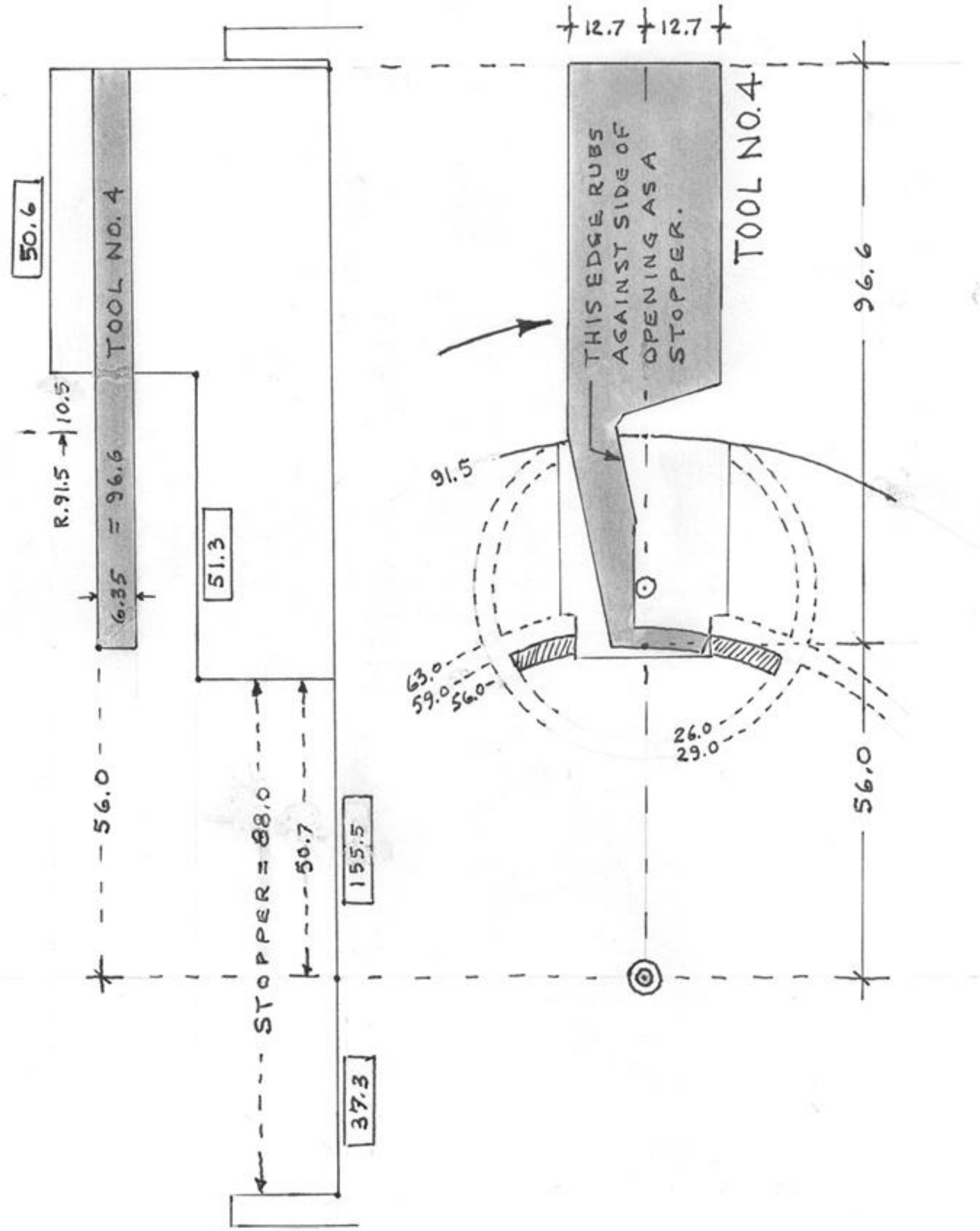
Tool N°		Item N°
1	______________	3
2	______________	4
3	______________	41
4	______________	42
5	______________	43
6	______________	44
7	______________	45
8	______________	46
9 -10	__________	47
11-12	__________	48
13	_____________	49
14-15	_________	50

ITEM NO. 41



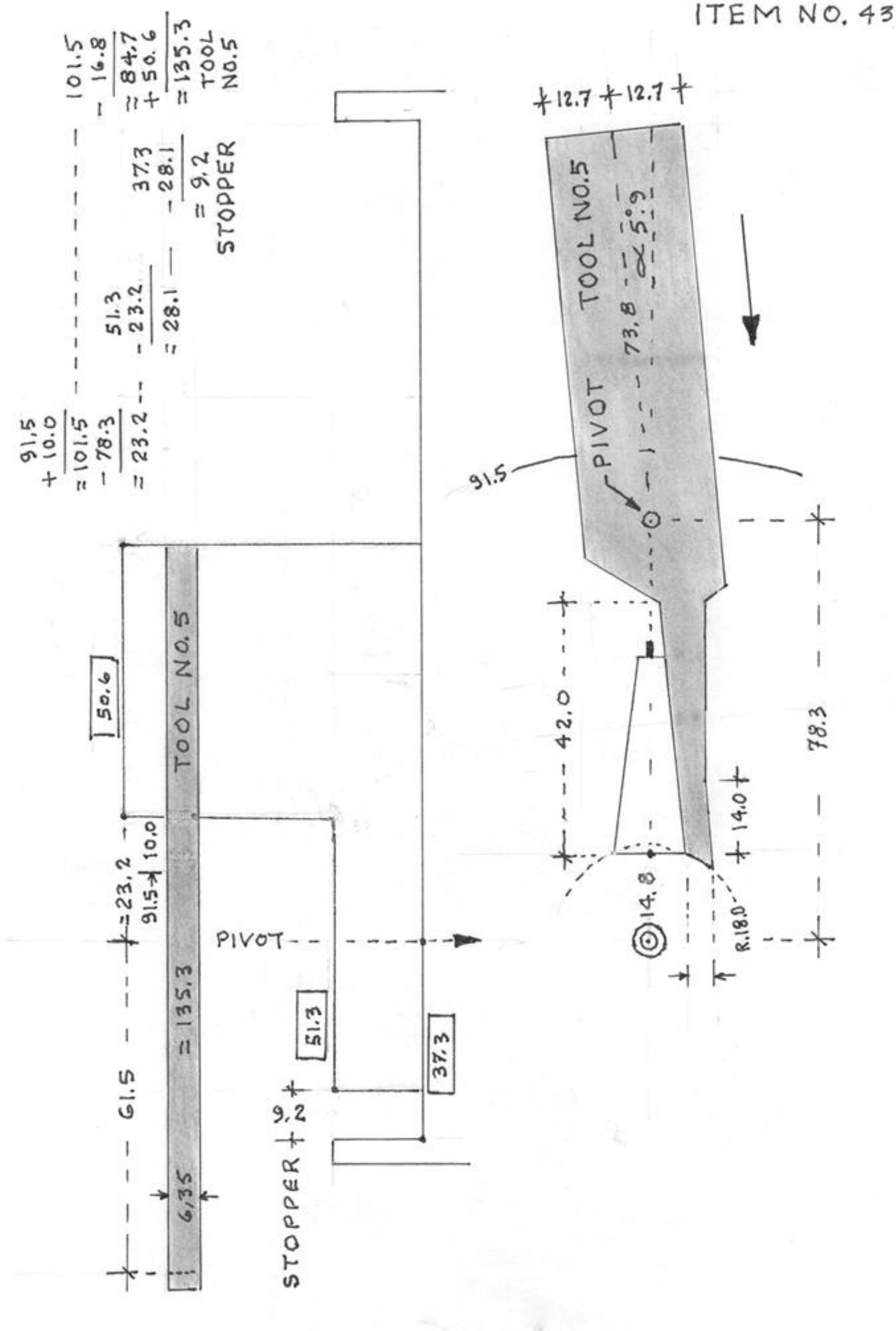
PIVOT AT 92.8 FROM
TOOL NO. 3
= 126.0
6.35
31.4
14.0
R. 91.5
50.6
= 55.5
STOPPER = 0.0
51.3
37.3
154.8
PIVOT
92.8
+ 14.0
= 106.8
- 51.3
= 55.5
106.8
- 31.4
= 75.4
+ 50.6
= 126.0
TOOL NO. 3
+ POINT OF TOOL 0.6 TO RAD. 32.0
12.7
12.7
126.0
68.0
14.0
44.0
TOOL NO. 3
∝ 5.9°
3.4
PIVOT
91.5
7.0
92.8
63.0
31.4
5.7
R. 32.0
R. 32.0
TOOL NO. 3
32.0
6.35
31.4
0.6
NOT TO SCALE

ITEM NO.42



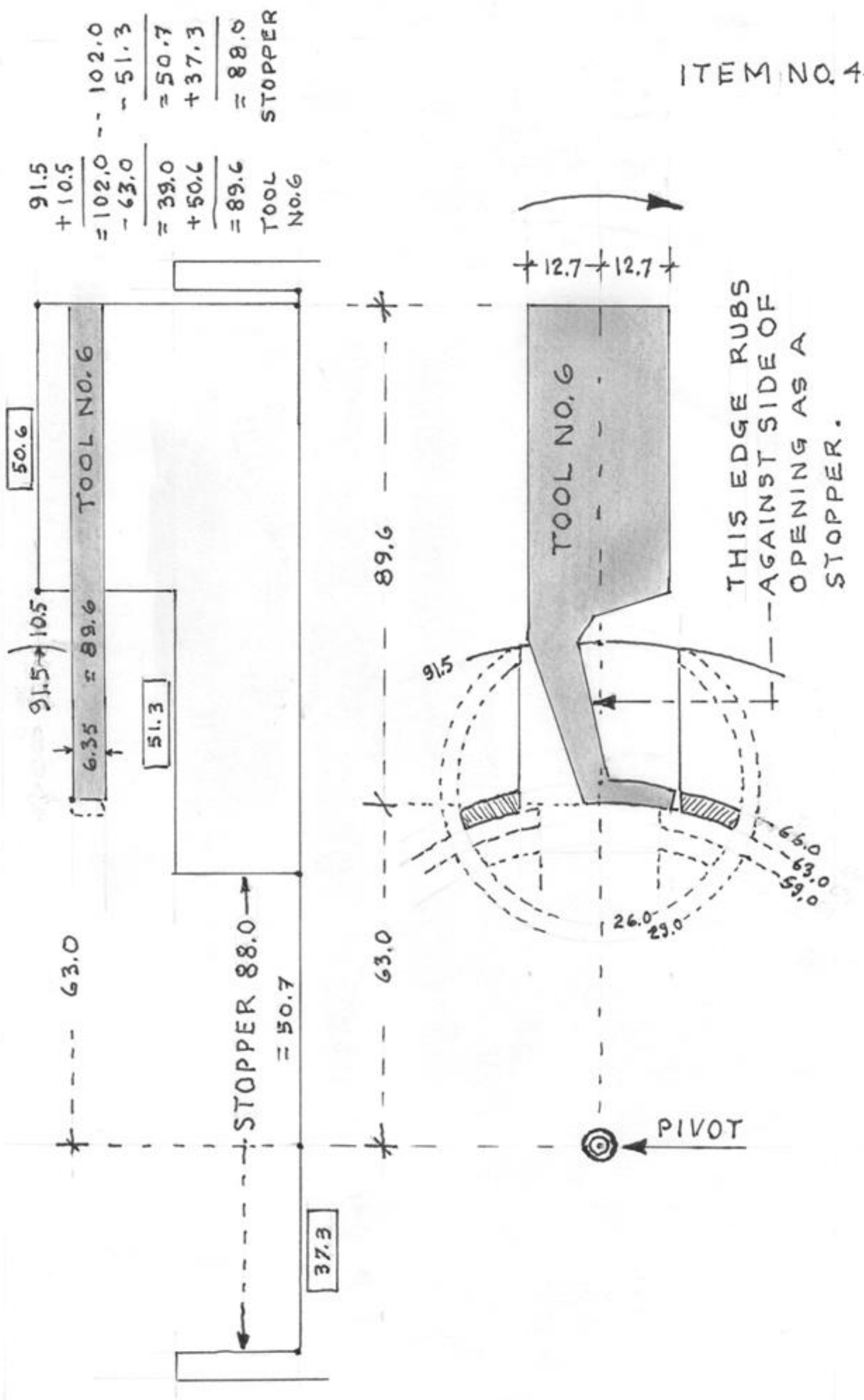
50.6
TOOL NO. 4
R.91.5
10.5
6.35 = 96.6
51.3
56.0
STOPPER = 88.0
50.7
155.5
37.3
12.7
12.7
THIS EDGE RUBS AGAINST SIDE OF OPENING AS A STOPPER.
TOOL NO.4
96.6
91.5
63.0
59.0
56.0
26.0
29.0
56.0

ITEM NO. 43



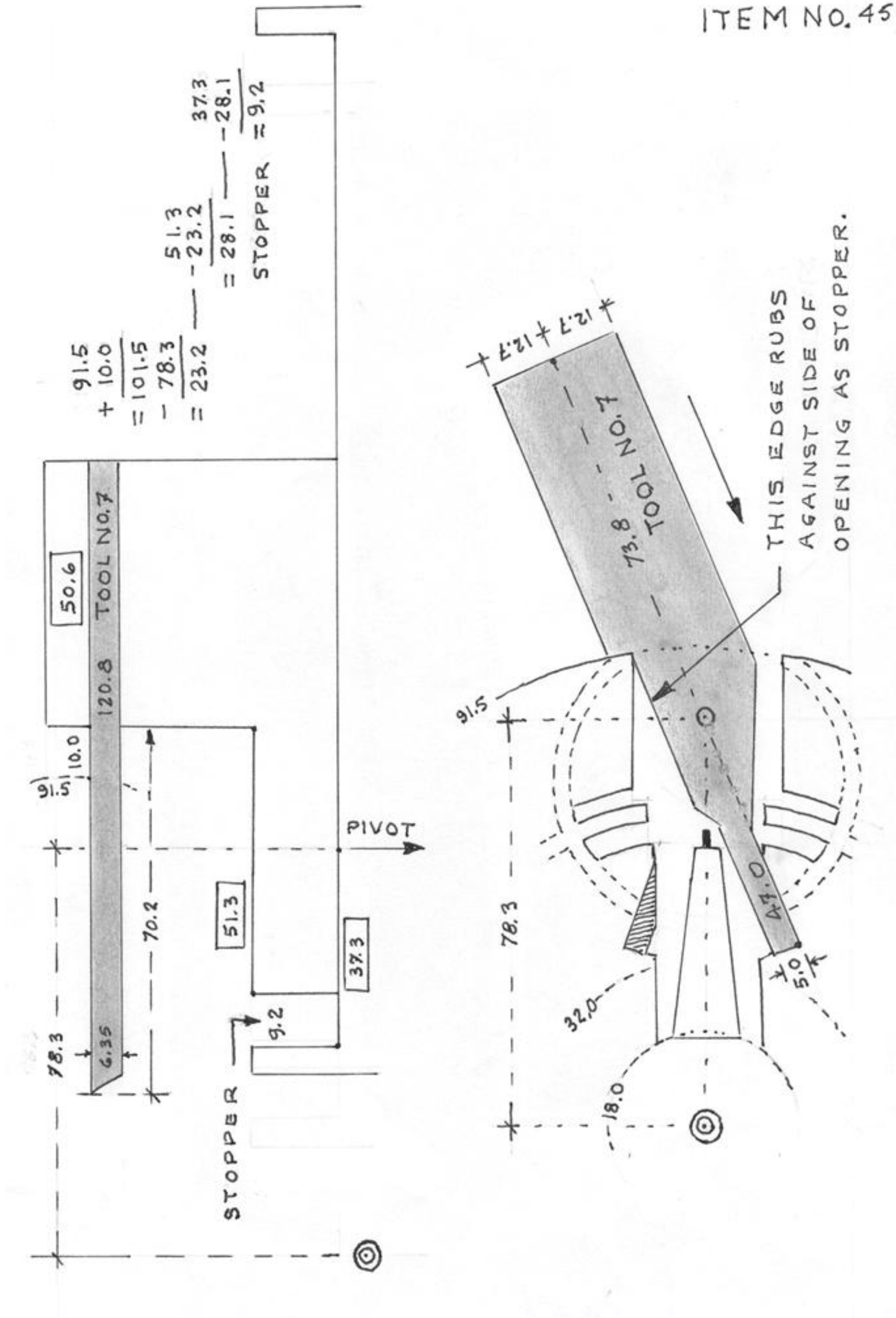
91.5
+ 10.0
= 101.5
- 78.3
= 23.2
51.3
- 23.2
= 28.1
37.3
- 28.1
= 9.2
STOPPER
101.5
- 16.8
= 84.7
+ 50.6
= 135.3
TOOL
No.5
TOOL NO.5
50.6
10.0
23.2
91.5
PIVOT
51.3
37.3
61.5
= 135.3
6.35
9.2
STOPPER
12.7
12.7
TOOL NO.5
73.8
5°9
PIVOT
91.5
42.0
78.3
14.0
14.8
R.18.0

ITEM NO. 44



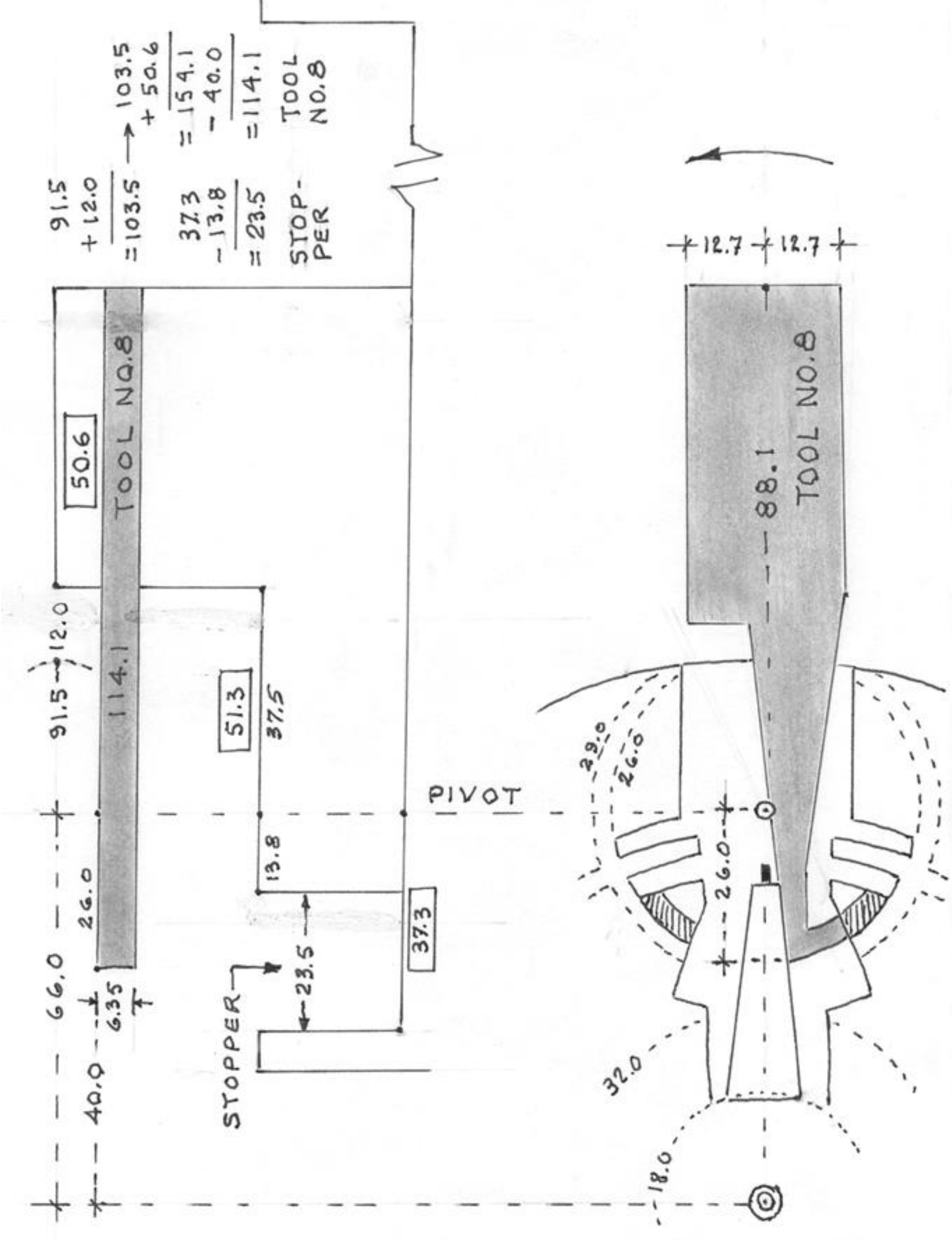
91.5
+10.5
=102.0
-63.0
=39.0
+50.6
=89.6
TOOL NO.6
102.0
-51.3
=50.7
+37.3
=88.0
STOPPER
TOOL NO. 6
50.6
10.5
91.5
=89.6
6.35
51.3
63.0
STOPPER 88.0
=50.7
37.3
12.7
12.7
89.6
63.0
91.5
66.0
63.0
59.0
26.0
29.0
PIVOT
THIS EDGE RUBS AGAINST SIDE OF OPENING AS A STOPPER.

ITEM NO. 45

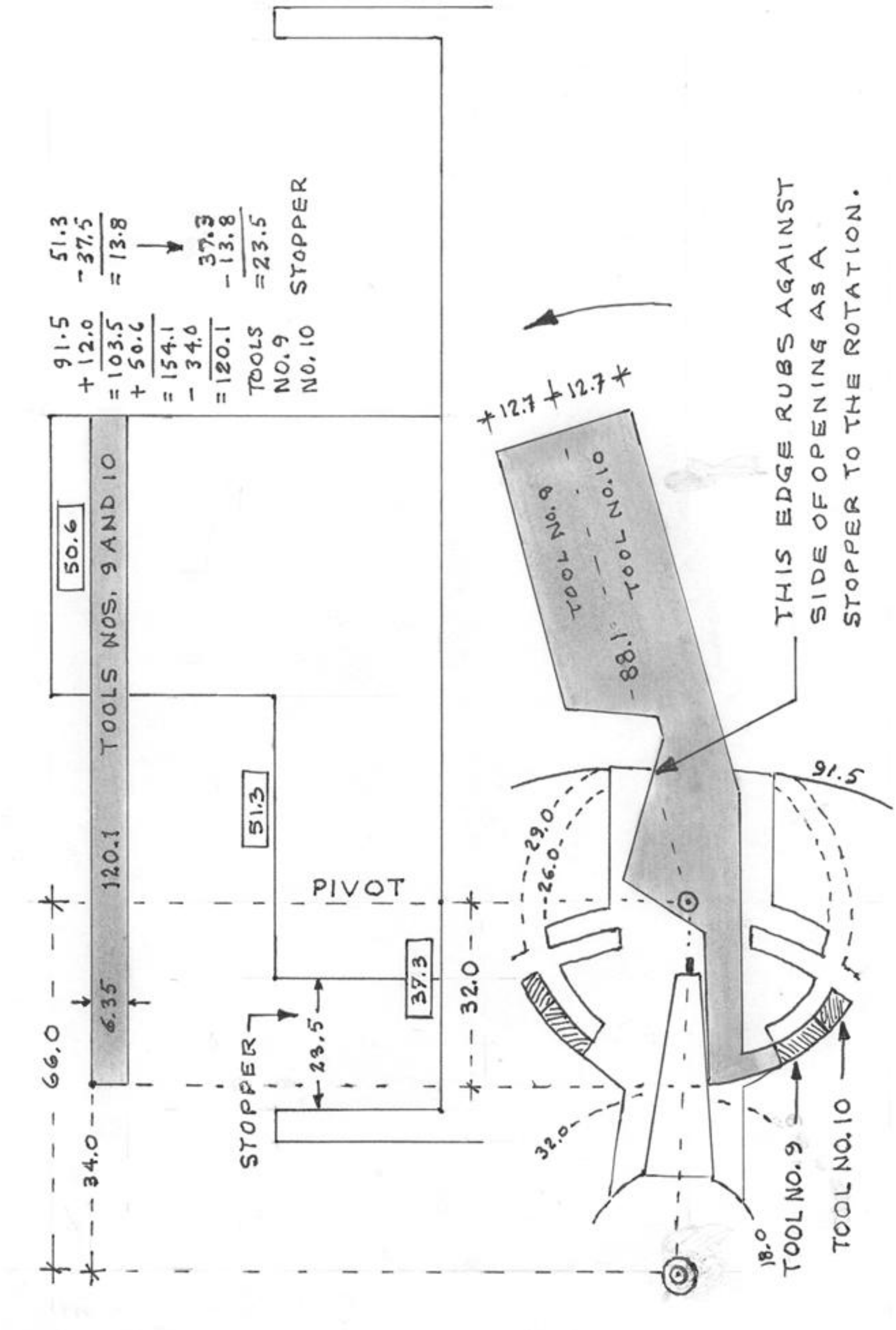


TOOL NO. 7
50.6
120.8
10.0
91.5
6.35
78.3
70.2
PIVOT
STOPPER
51.3
37.3
9.2
91.5 + 10.0 = 101.5 − 78.3 = 23.2
51.3 − 23.2 = 28.1
37.3 − 28.1 = 9.2
STOPPER ≈ 9.2
73.8
12.7
47.0
5.0
32.0
18.0
THIS EDGE RUBS AGAINST SIDE OF OPENING AS STOPPER.

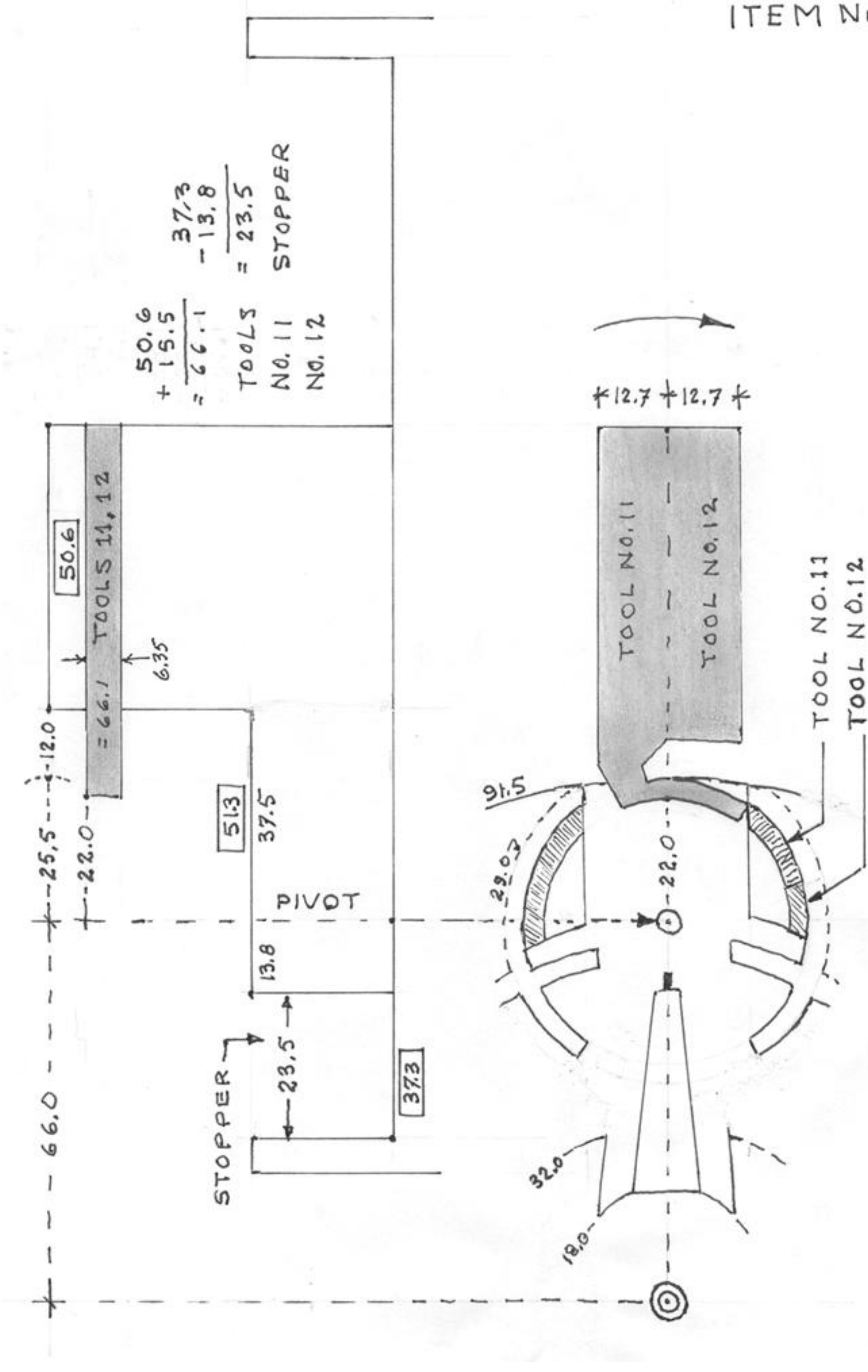
ITEM NO.46


91.5
+ 12.0
= 103.5
103.5
+ 50.6
= 154.1
- 40.0
= 114.1
TOOL NO.8
37.3
- 13.8
= 23.5
STOP-PER
50.6
TOOL NO.8
114.1
91.5
12.0
51.3
37.5
PIVOT
13.8
26.0
37.3
66.0
6.35
40.0
STOPPER
23.5
12.7
12.7
88.1
TOOL NO.8
29.0
26.0
26.0
32.0
18.0

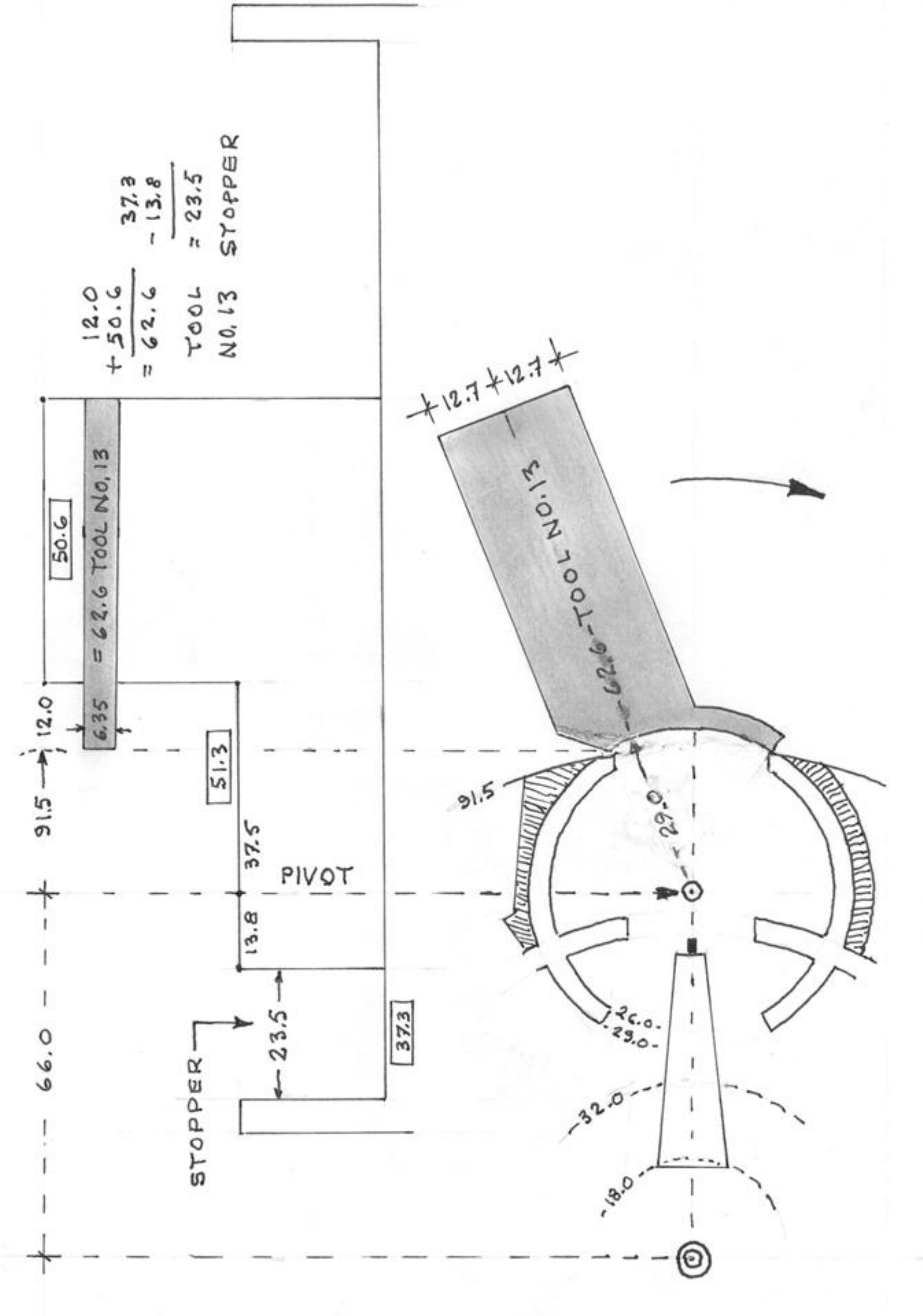
ITEM NO. 47


THIS EDGE RUBS AGAINST SIDE OF OPENING AS A STOPPER TO THE ROTATION.
TOOLS NOS. 9 AND 10
50.6
51.3
120.1
37.3
6.35
66.0
34.0
32.0
23.5
PIVOT
STOPPER
TOOL No. 9
TOOL No. 10
88.1
12.7
12.7
91.5
29.0
26.0
32.0
18.0
TOOL NO. 9
TOOL NO. 10
91.5
+ 12.0
= 103.5
+ 50.6
= 154.1
− 34.0
= 120.1
TOOLS
NO. 9
NO. 10
51.3
− 37.5
= 13.8
37.3
− 13.8
= 23.5
STOPPER

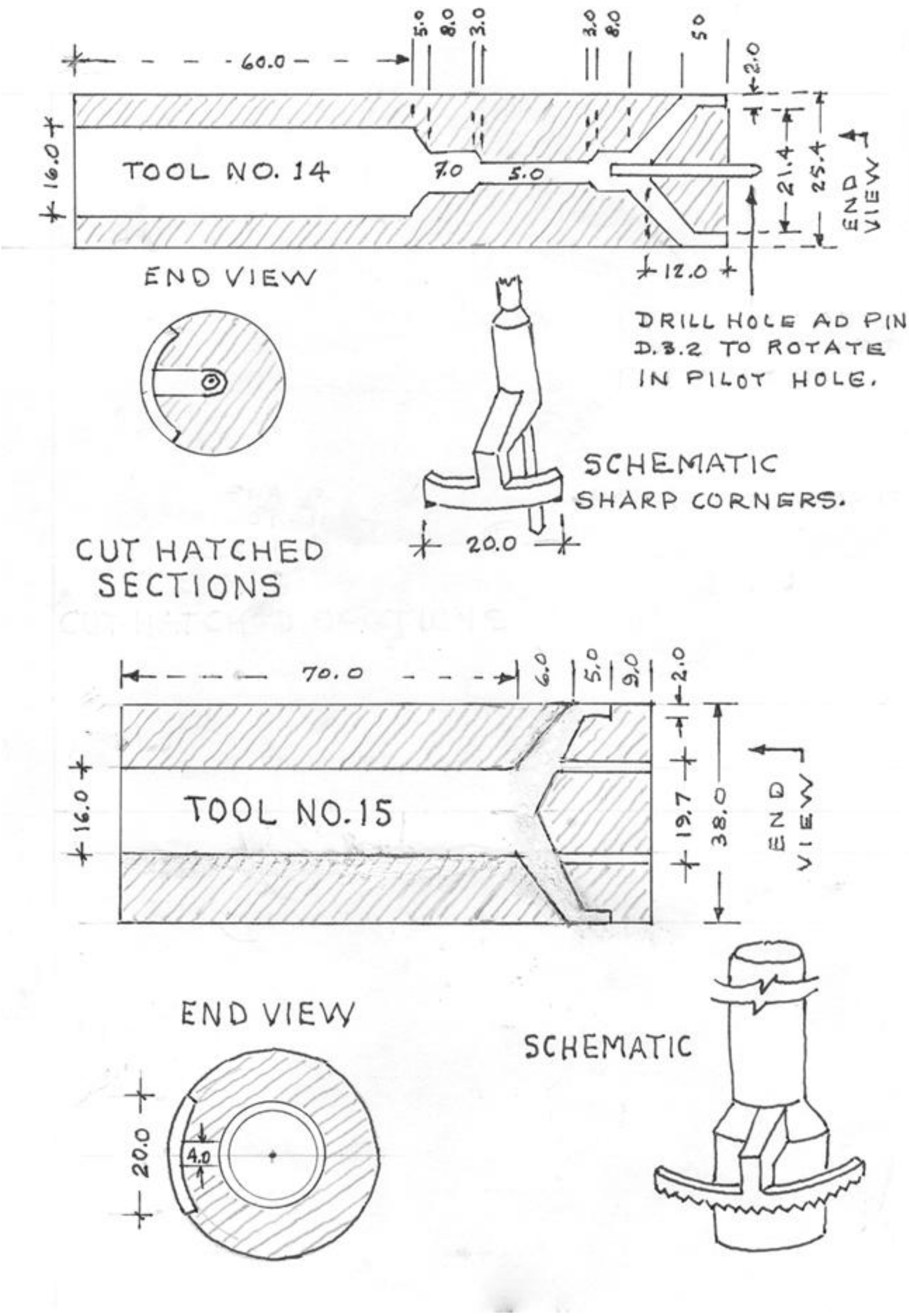
ITEM NO. 48


50.6
+ 15.5
= 66.1
TOOLS
NO. 11
NO. 12
37.3
- 13.8
= 23.5
STOPPER
50.6
TOOLS 11, 12
= 66.1
6.35
12.0
25.5
22.0
51.3
37.5
PIVOT
13.8
STOPPER
23.5
37.3
66.0
12.7
12.7
TOOL NO. 11
TOOL NO. 12
91.5
29.03
22.0
TOOL NO. 11
TOOL NO. 12
32.0
18.0

ITEM NO.49


12.0
+ 50.6
= 62.6
TOOL NO.13
37.3
- 13.8
= 23.5 STOPPER
50.6
= 62.6 TOOL NO.13
6.35
12.0
91.5
51.3
37.5
PIVOT
13.8
23.5
STOPPER
66.0
37.3
12.7
12.7
62.6 TOOL NO.13
91.5
29.0
26.0
29.0
32.0
18.0

ITEM NO. 50


TOOL NO. 14
60.0
5.0
8.0
3.0
3.0
8.0
5.0
2.0
16.0
7.0
5.0
21.4
25.4
END VIEW
12.0
END VIEW
DRILL HOLE AD PIN D.3.2 TO ROTATE IN PILOT HOLE.
SCHEMATIC
SHARP CORNERS.
20.0
CUT HATCHED SECTIONS
TOOL NO.15
70.0
6.0
5.0
9.0
2.0
16.0
19.7
38.0
END VIEW
END VIEW
20.0
4.0
SCHEMATIC

Tour de Force

K - “Mysterium Cosmographicum”

Claude LETHIECQ

~ *Sequence of operations* ~

(General)

Item

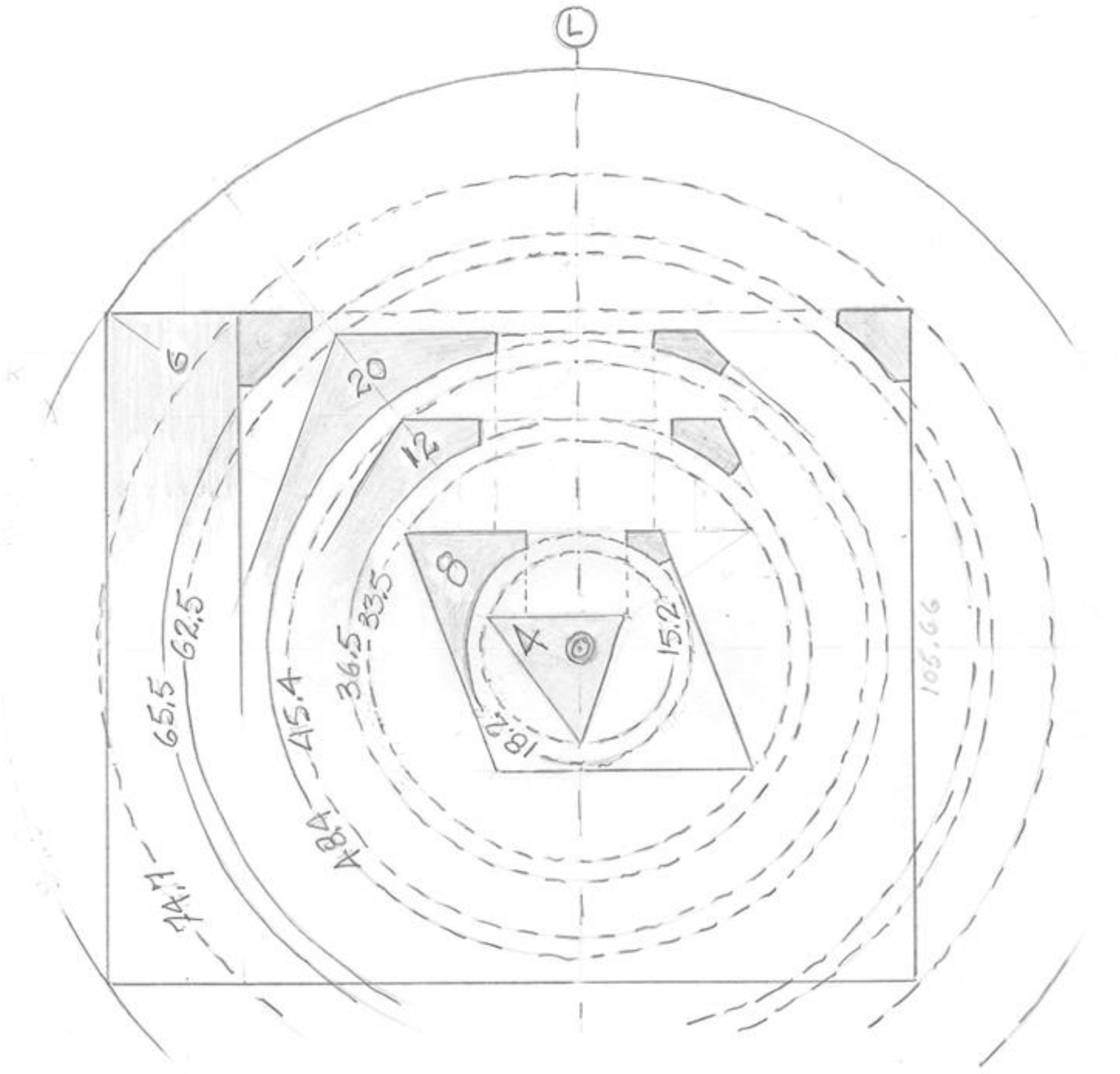
1. Draw cross-section
2. List of Ⓛ and Ⓢ points for the 5 polyhedrons
3. Use same chuck and ring as “Genesis”
4. With head N°1 turn R91.5 sphere
5. Make tools N°1 to 10 included

~ Hexahedron ~

6. Mark 6 Ⓛ points and 8 Ⓢ points
7. Set sphere in chuck, align an Ⓛ point, set ring
8. Set jig pivot at 91.5 from edge of sphere
9. Drill hole Ø25.4 depth 29.0 (28.1 from edge of hole)
10. Cut hatched section as shown
11. Cut hatched section to R62.5 with tool N°1
12. Cut hatched section with tool N°2
13. Cut vertically 41.7 from Ⓛ line
14. Wedge between R65.5 and R62.5 add a drop of hot melt glue (x4)
15. Loosen ring, align to other Ⓛ point, reset ring
16. Repeat items N°7 to 15 included till all 6 faces are done
17. Withdraw all wedges to free inside sphere

ITEM NO. 1

MYSTERIUM COSMOGRAPHICUM CROSS-SECTION (LEFT SIDE OF CUBE IS ON A DIAGONAL).

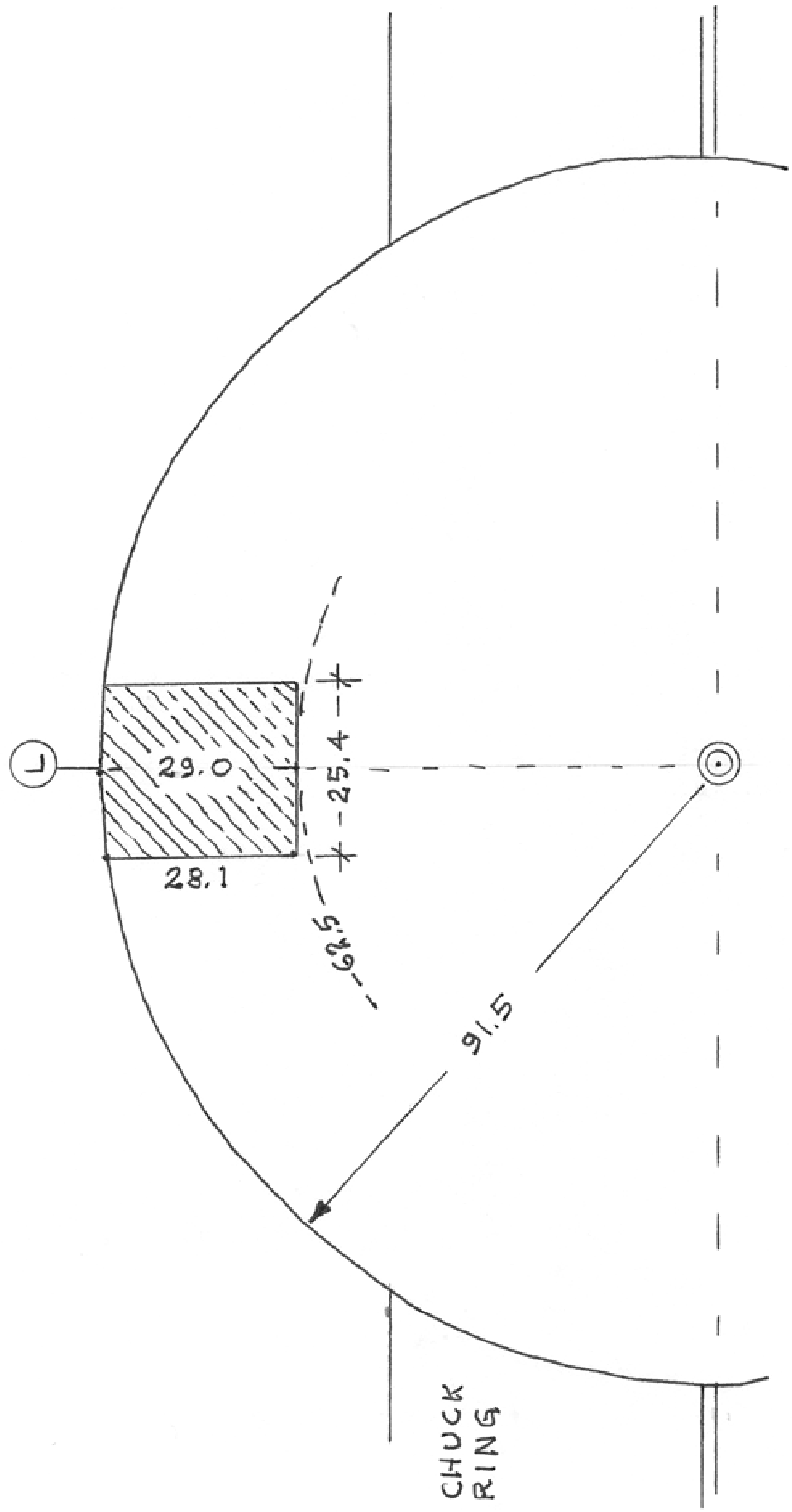


NOTE: NOS. 4, 6, 8, 12 AND 20 INDICATE THE NUMBER OF FACES OF EACH POLYHEDRON.

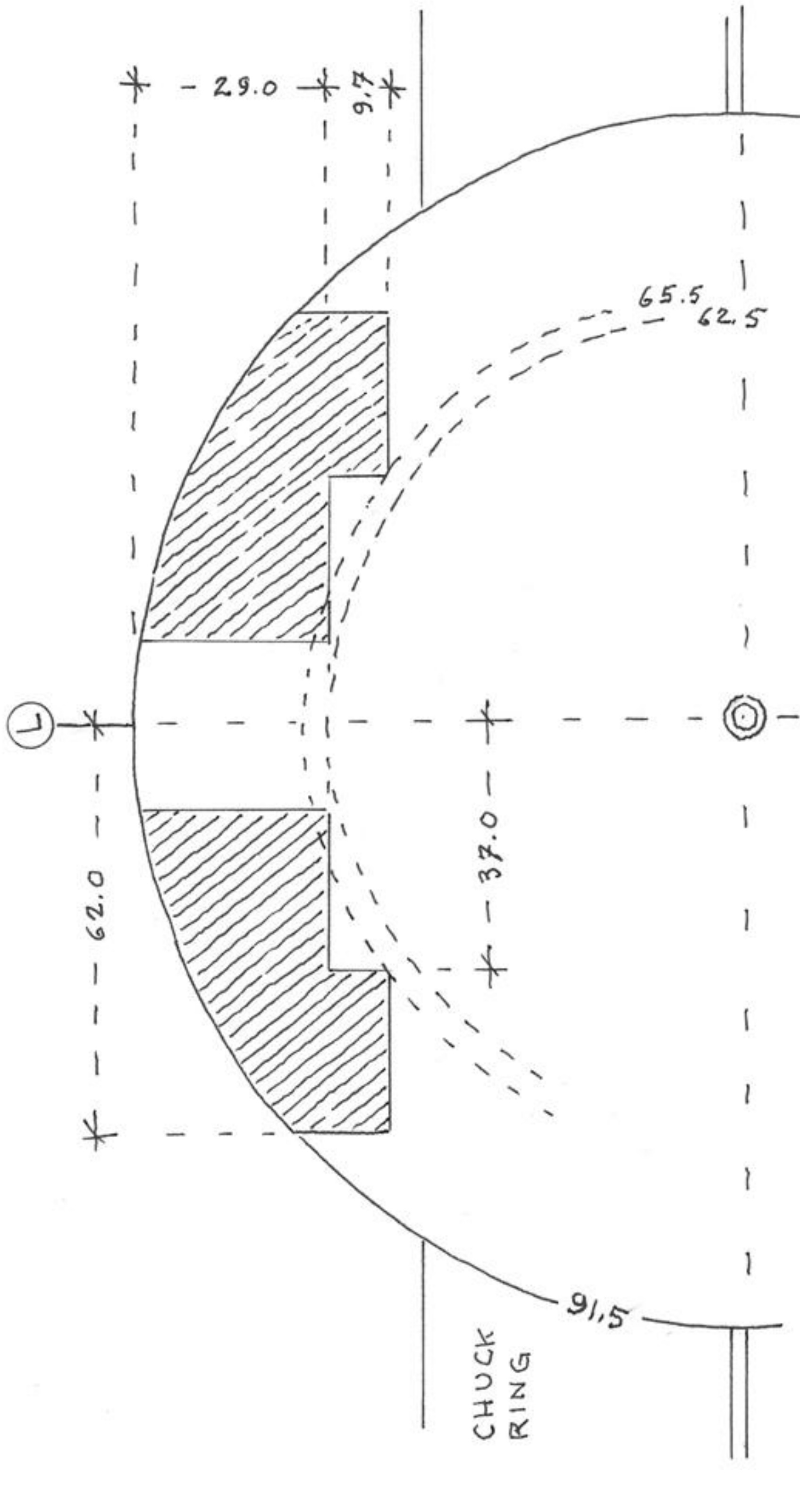
~ *Marking the sphere* ~

6	HEXAHEDRON	L-L = Ø183.0 x 0.7071 = 129.4
		L-S = Ø183.0 x 0.4597 = 84.1
20	ICOSAHEDRON	L-L = Ø125.0 x 0.3568 = 44.6
		L-S = Ø125.0 x 0.3204 = 40.0
12	DODECAHEDRON	L-L = Ø90.8 x 0.5257 = 47.7
		L-S = Ø90.8 x 0.3204 = 29.1
8	OCTAHEDRON	L-L = Ø67.0 x 0.5774 = 38.7
		L-S = Ø67.0 x 0.4597 = 30.8
4	TETRAHEDRON	L-L = Ø30.4 x 0.8165 = 24.8
		L-S = Ø30.4 x 0.5774 = 17.6

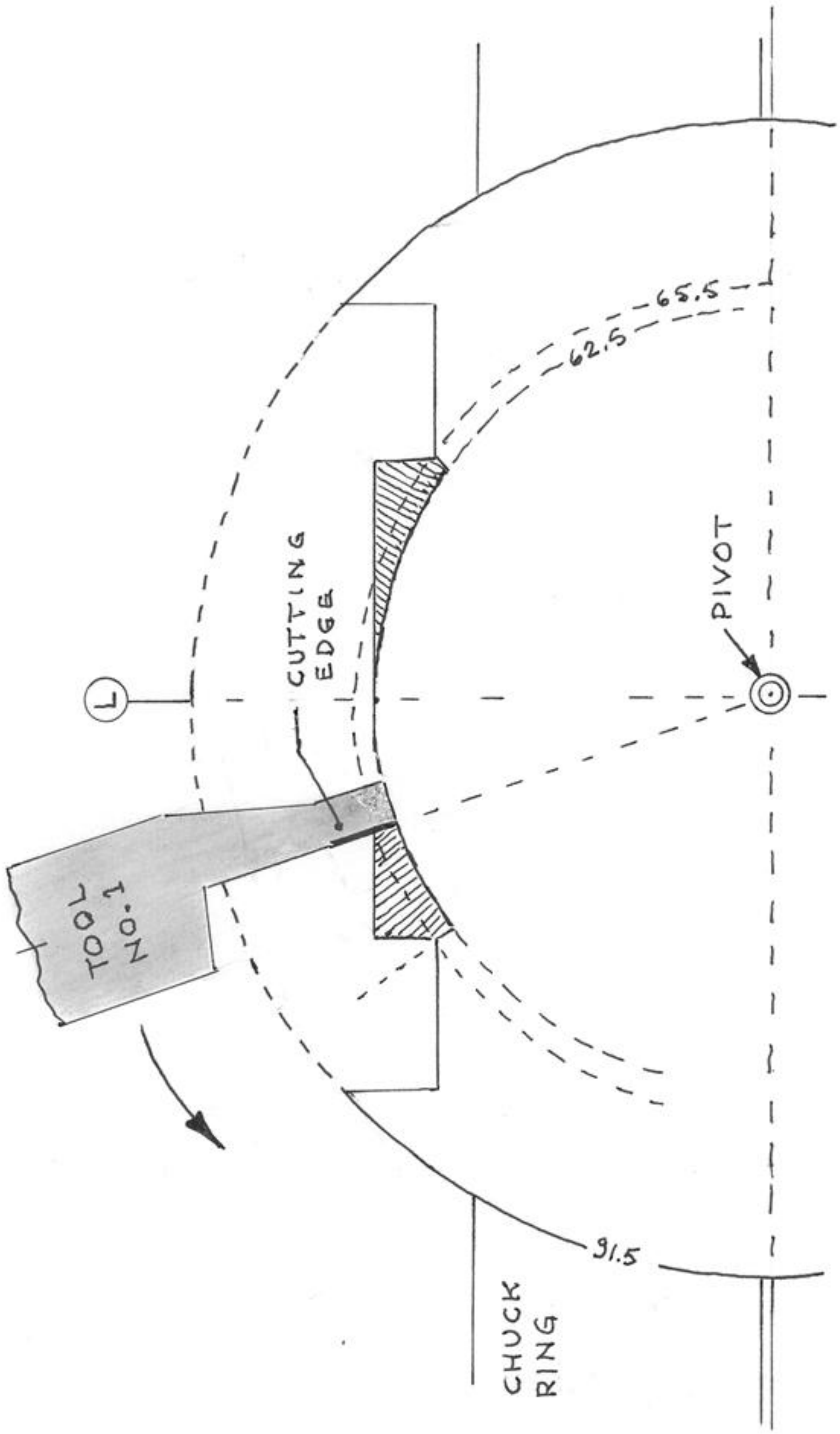
ITEM NO. 9



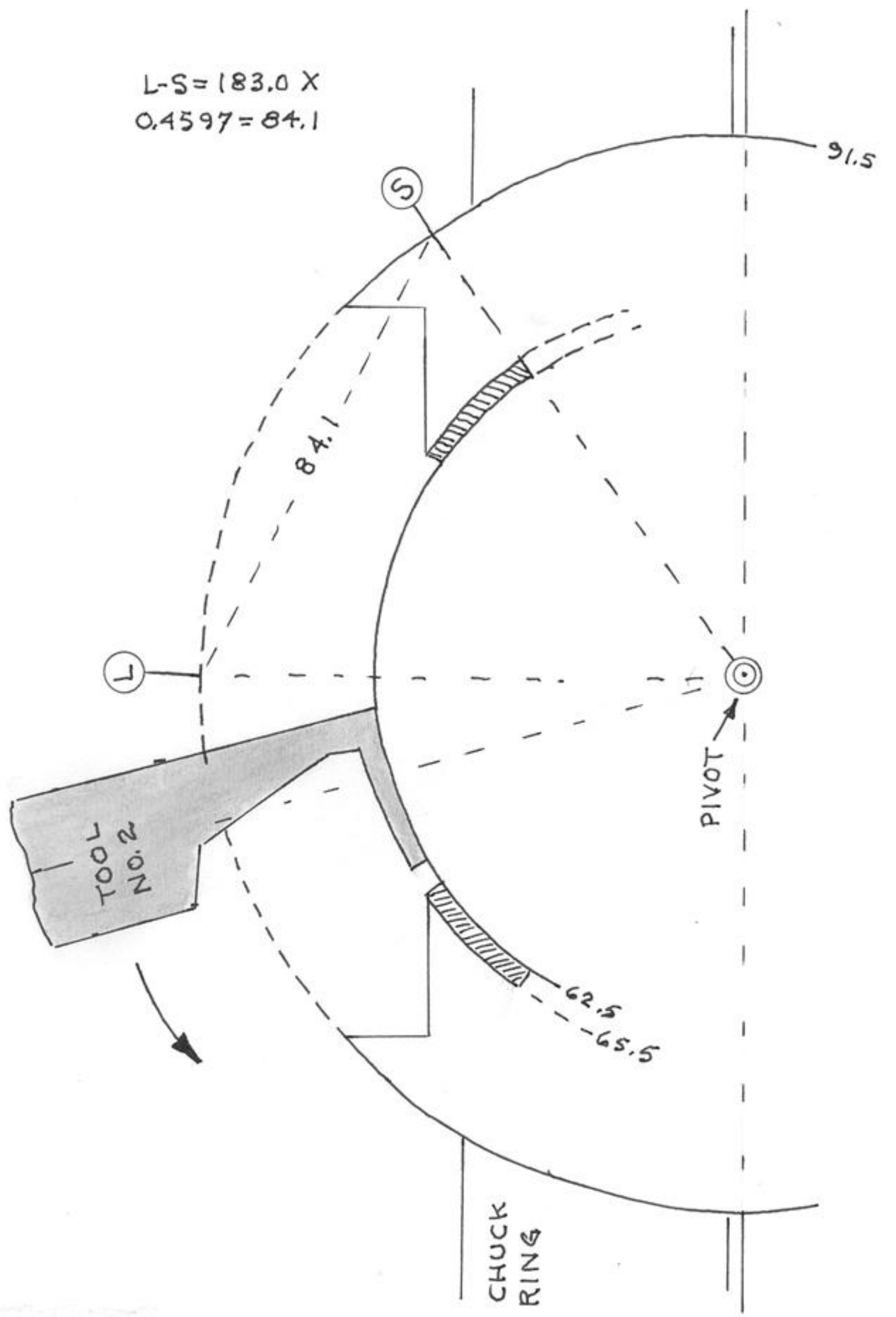
ITEM NO.10



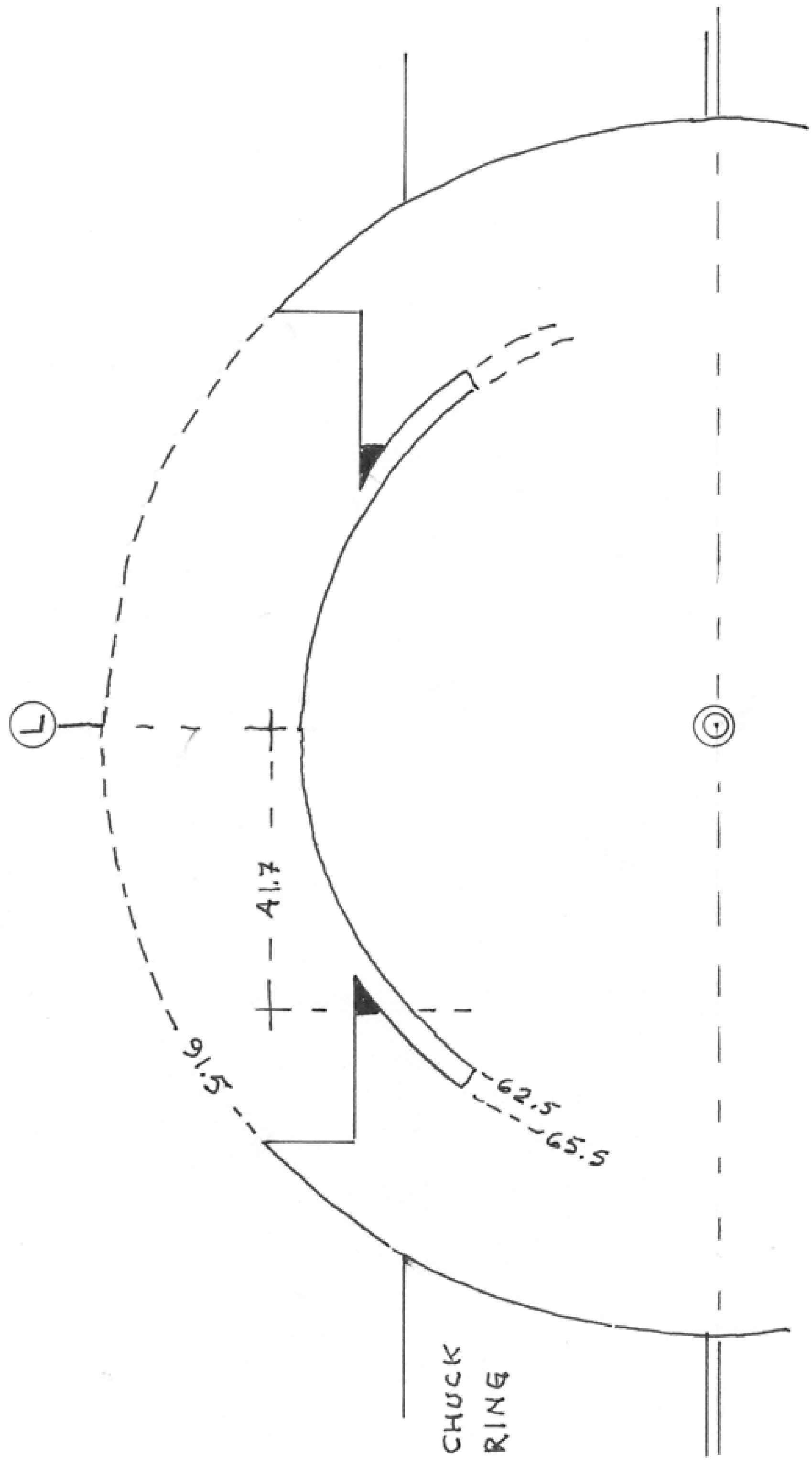
ITEM NO. 11



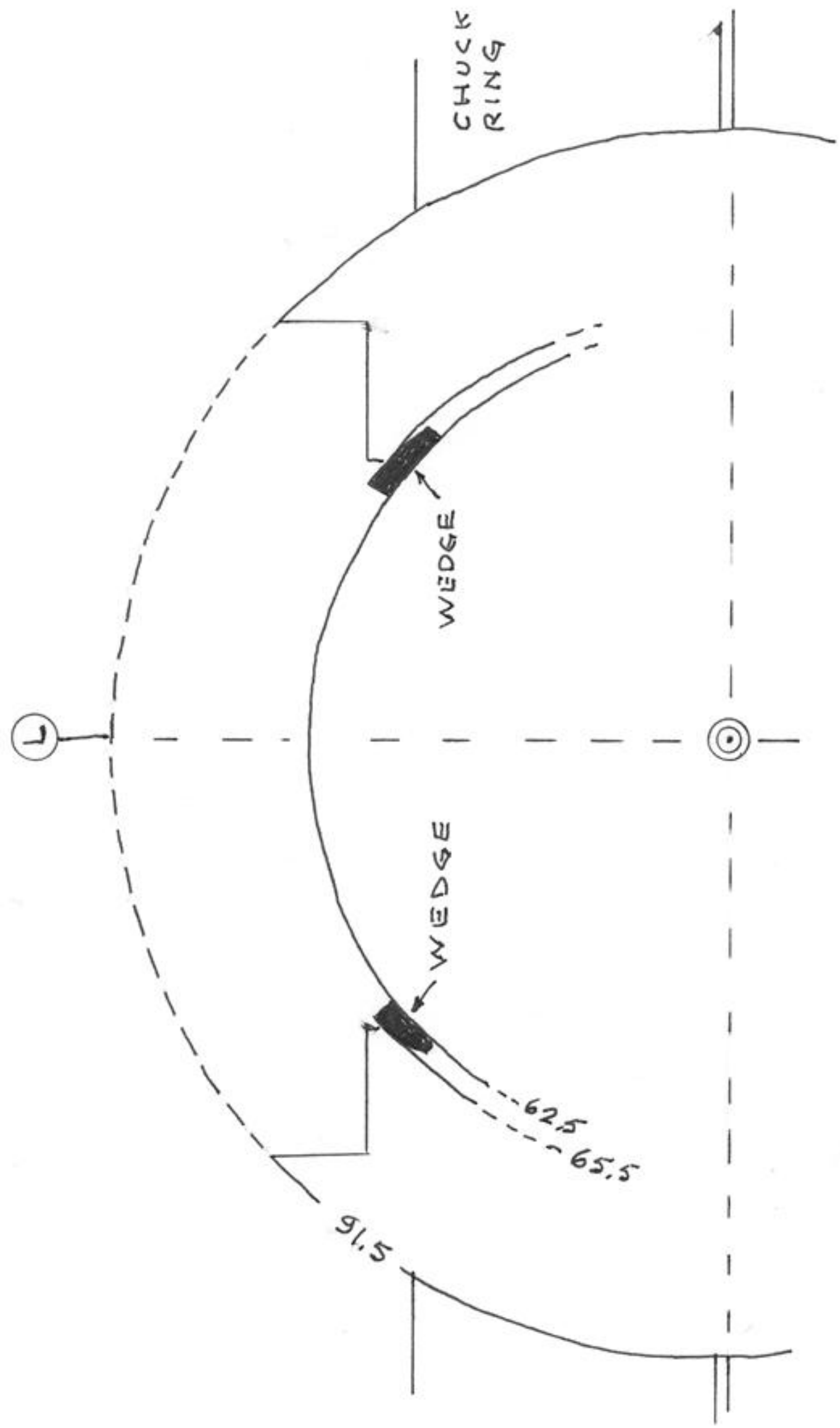
ITEM NO. 12


L-S = 183.0 X
0.4597 = 84.1
91.5
S
84.1
L
PIVOT
TOOL
No. 2
62.5
65.5
CHUCK
RING

ITEM NO. 13



ITEM NO. 14



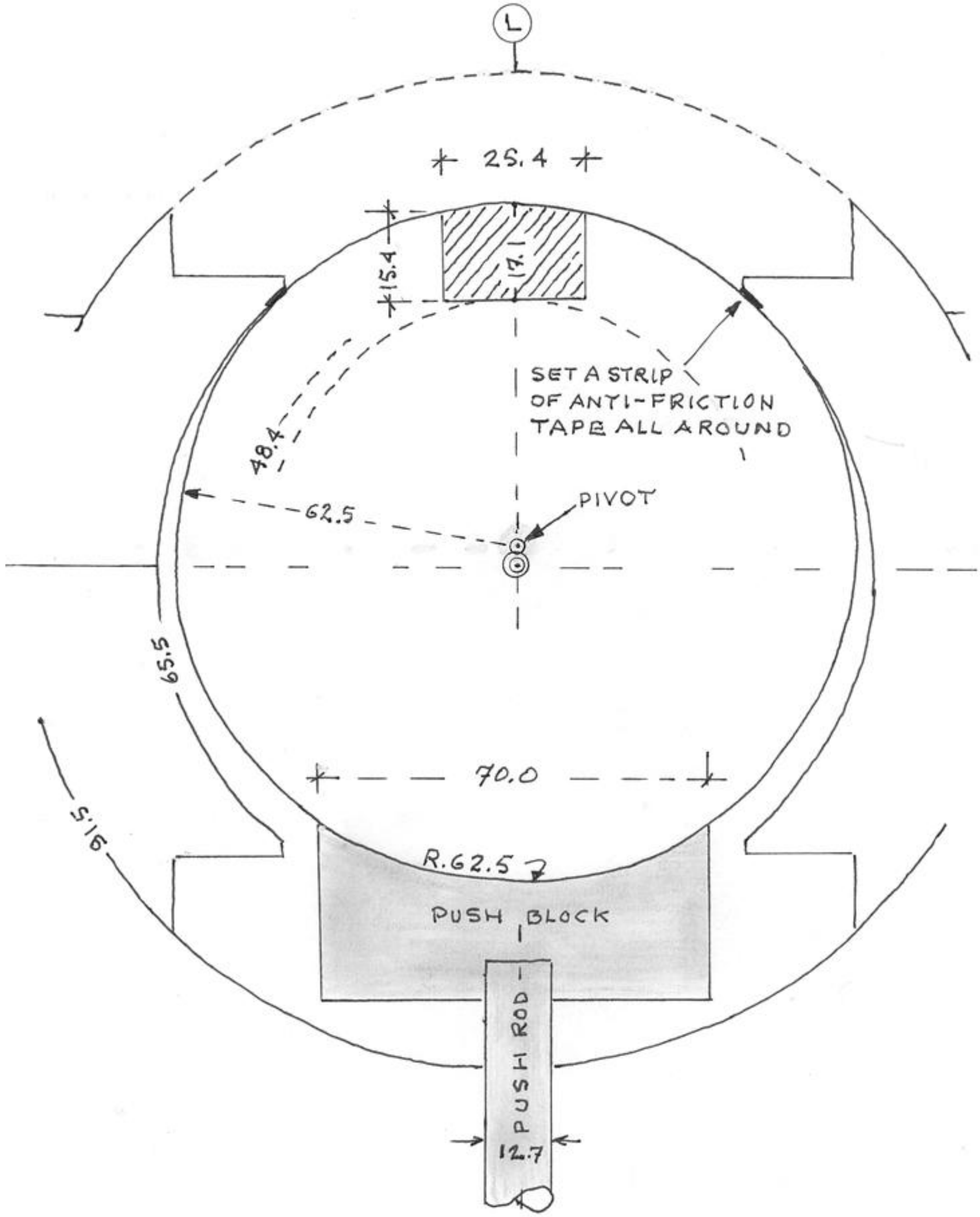
~ Sequence of operations ~

~ ICOSAHEDRON ~

Item

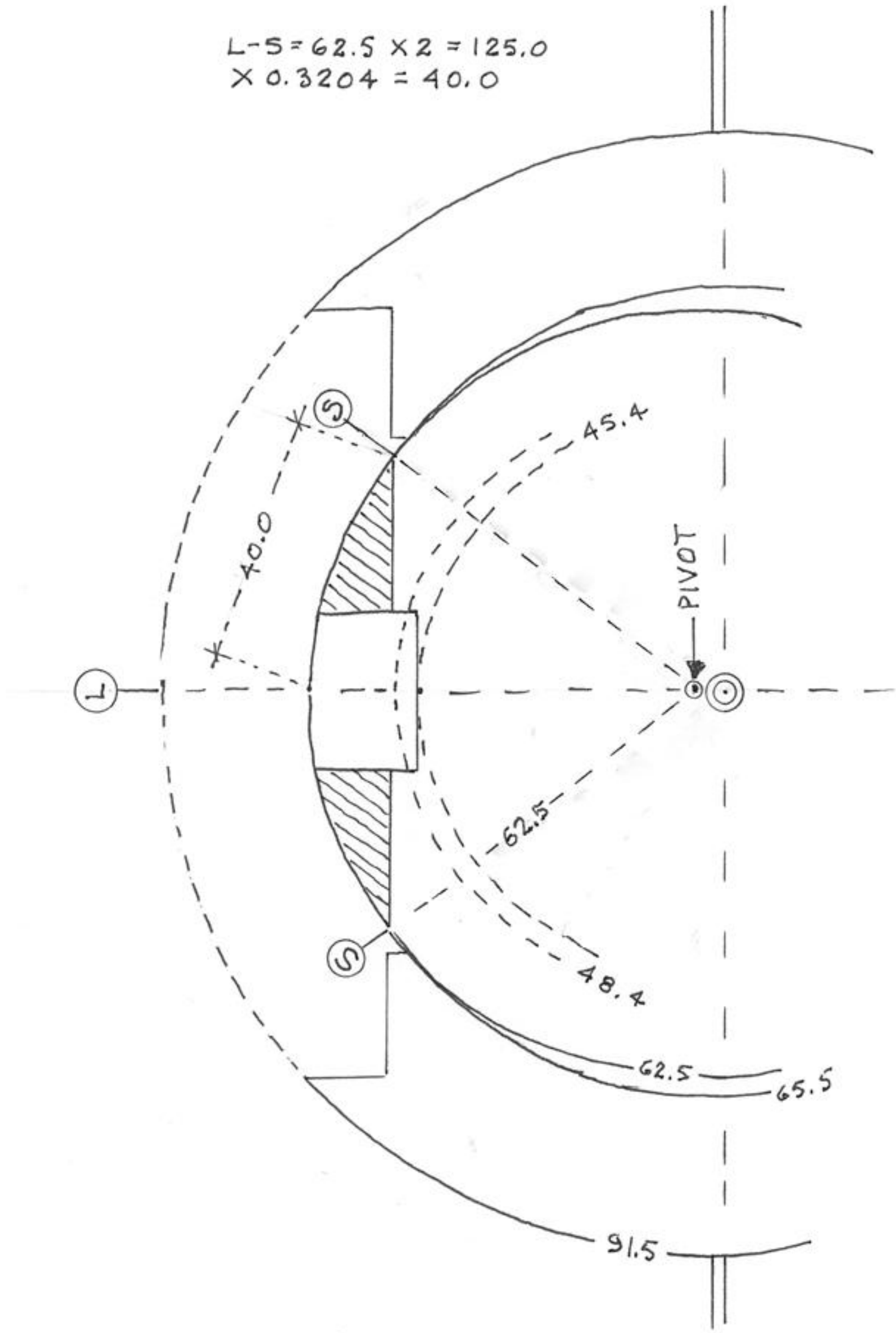
18. Mark 20 Ⓛ points and 12 Ⓢ points
19. Set a strip of anti-friction tape
20. Line up an Ⓛ point
    - Push R62.5 sphere tight against tape, set ring
    - Set pivot of sphere jig 62.5 from edge of sphere
    - Drill hole Ø25.4 depth 17.1 (15.4 at edge of hole)
21. Cut hatched section up to Ⓢ point
22. Cut black section with tool N°3, pivot at 45.4
23. Cut hatched section with tool N°4
24. Wedge between R48.4 and R45.4.
    - Make and set cap
25. Loosen push rod and turn sphere to another Ⓛ point
    - Line up and reset push rod.
    - Repeat items N°20 to 24 till all 20 faces are done.
    - Withdraw all wedges to free inside R45.4 sphere.

ITEM NO. 20

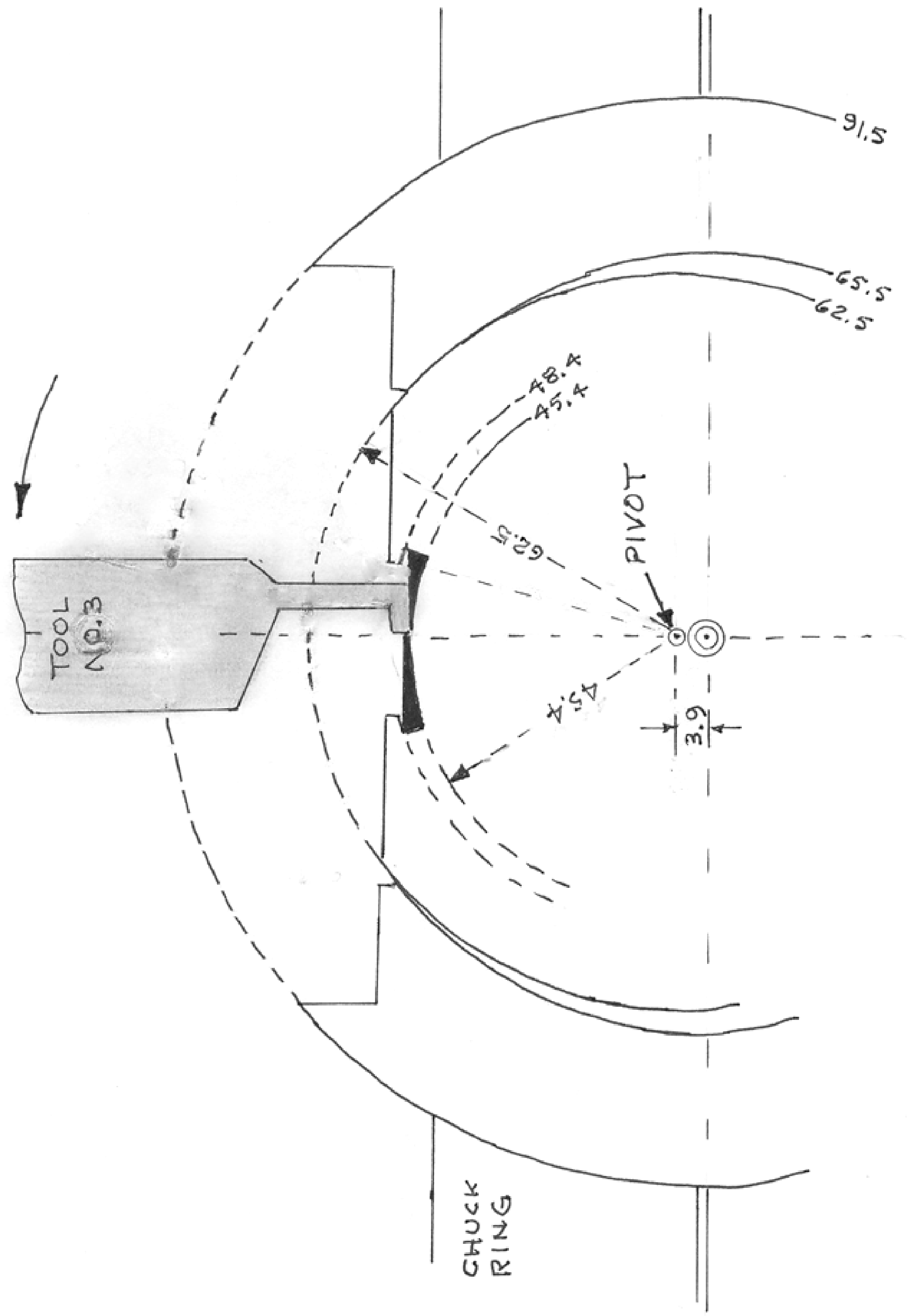


L
25.4
15.4
17.1
48.4
SET A STRIP
OF ANTI-FRICTION
TAPE ALL AROUND
62.5
PIVOT
65.5
91.5
70.0
R.62.5
PUSH BLOCK
PUSH ROD
12.7

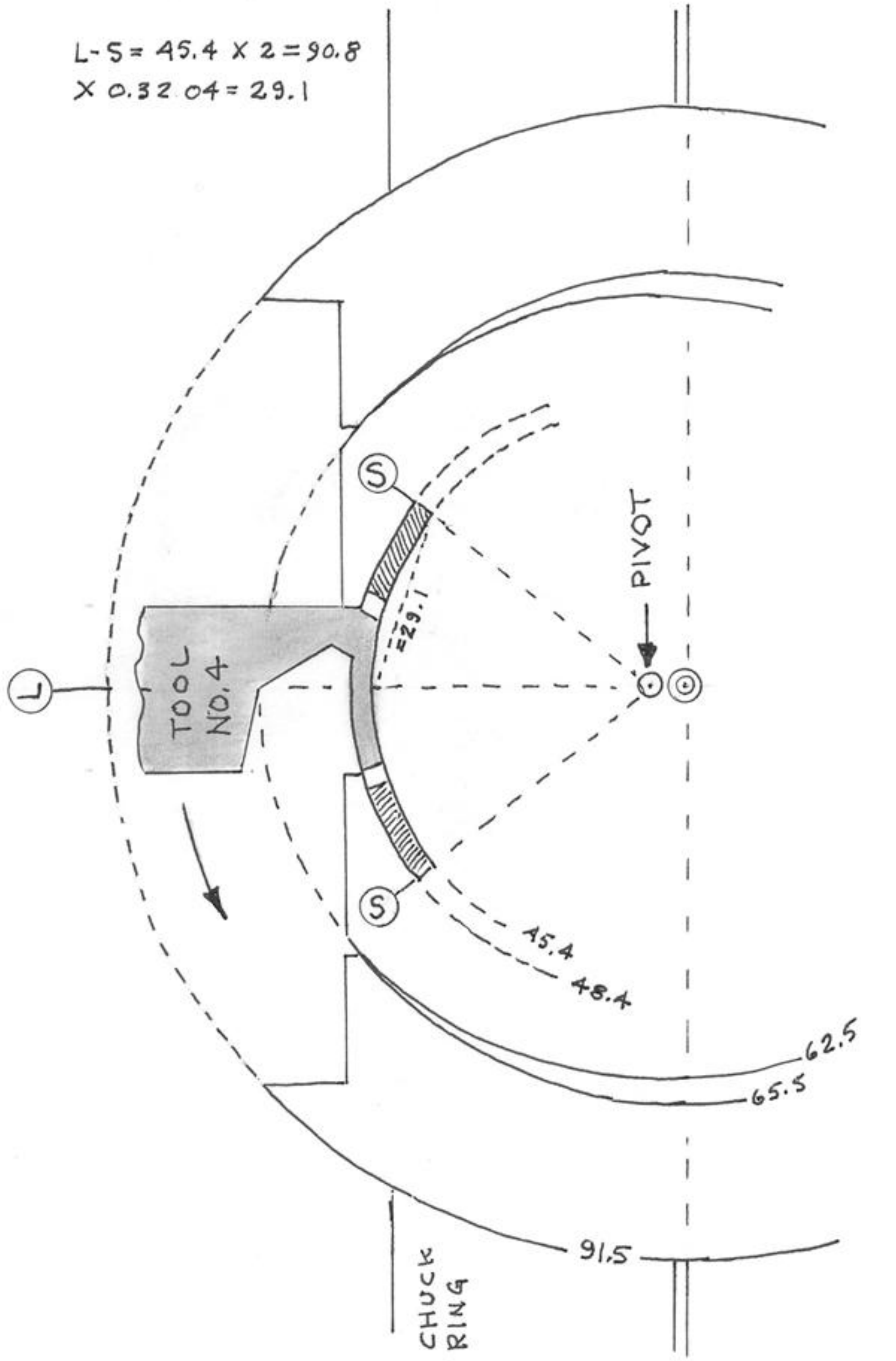
ITEM NO. 21



ITEM NO. 22

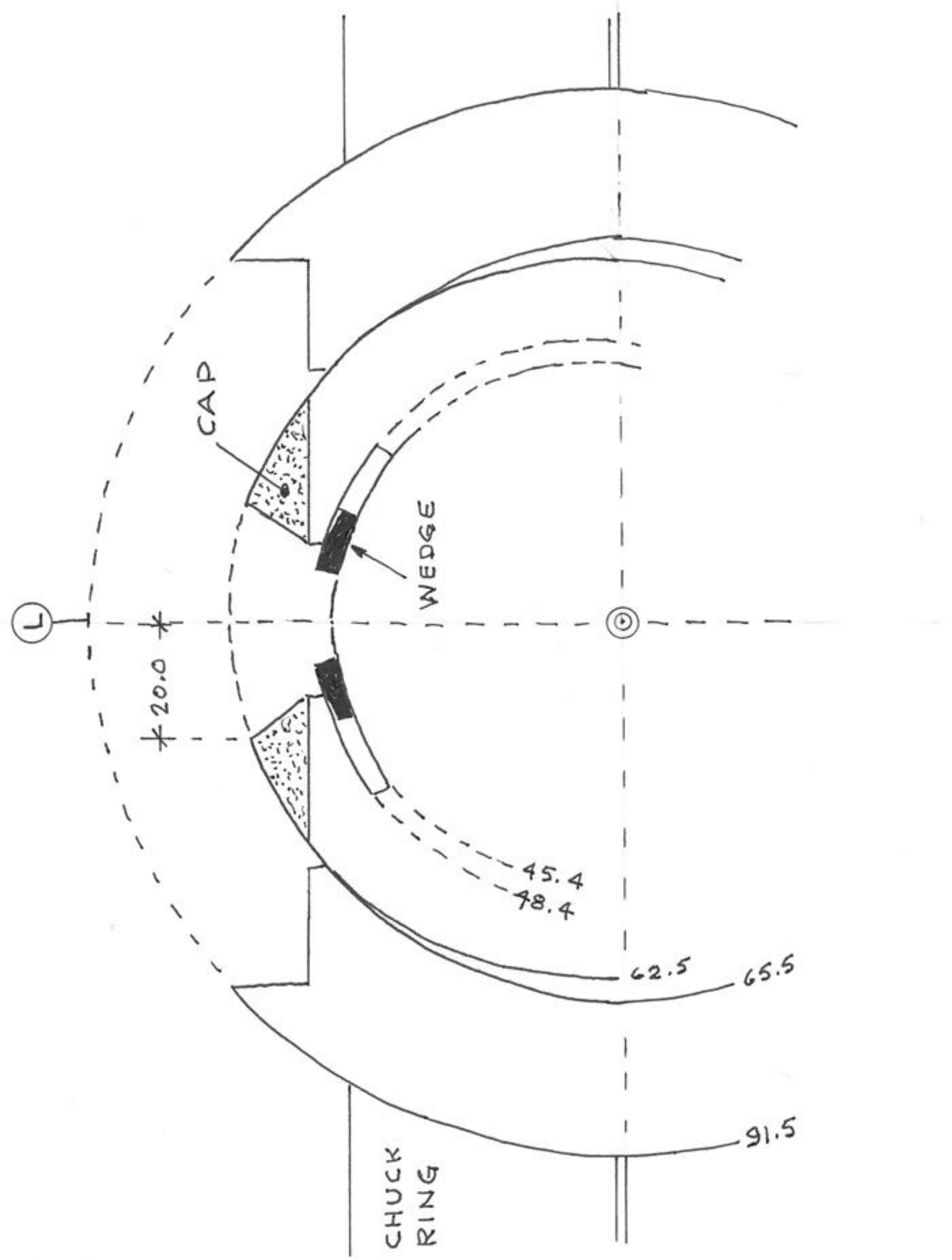


ITEM NO. 23



L-S = 45.4 X 2 = 90.8
X 0.32 04 = 29.1
PIVOT
TOOL NO. 4
L
S
S
=29.1
45.4
48.4
62.5
65.5
91.5
CHUCK RING

ITEM NO. 24



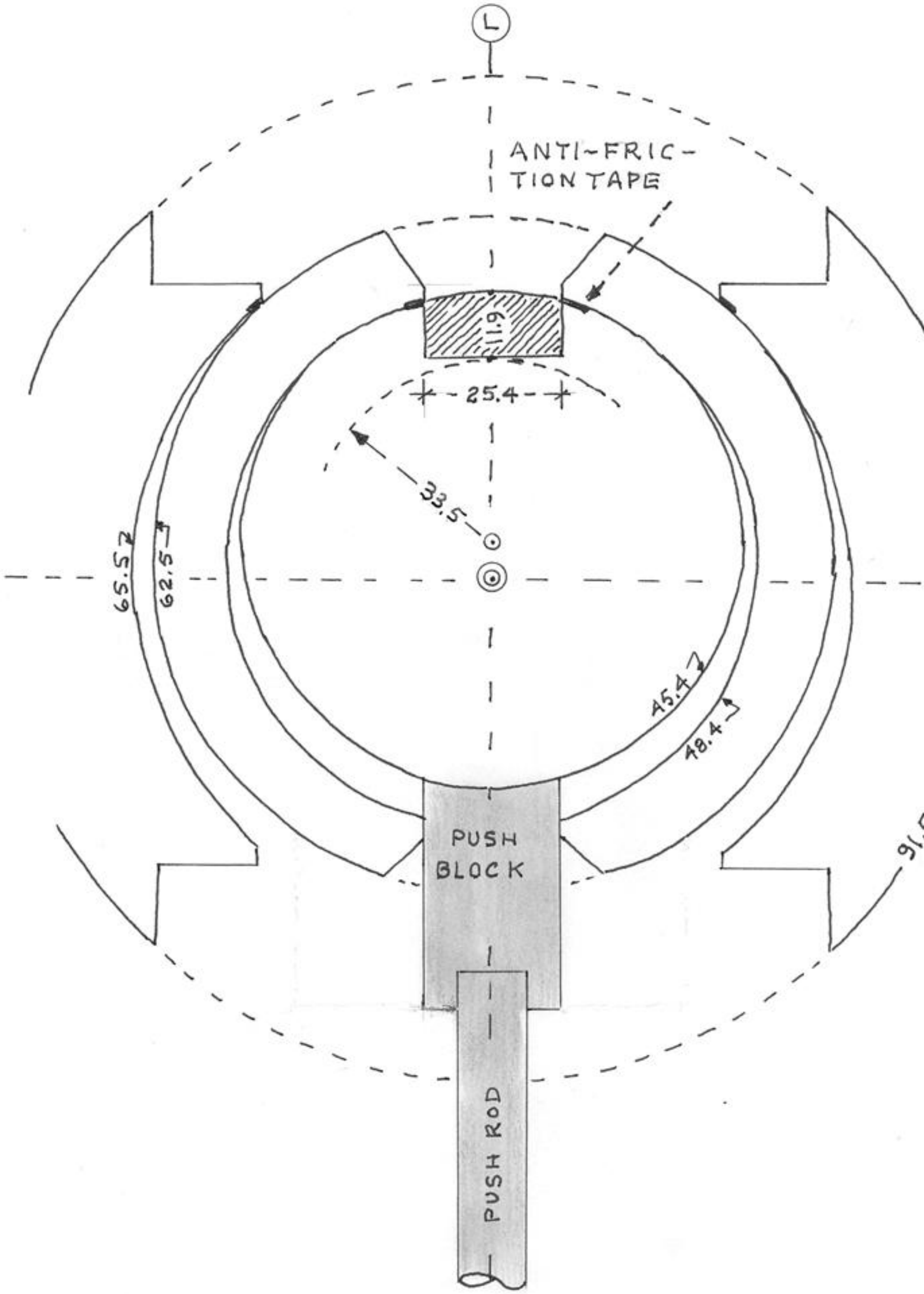
~ *Sequence of operations* ~

~ *DODECAHEDRON* ~

Item

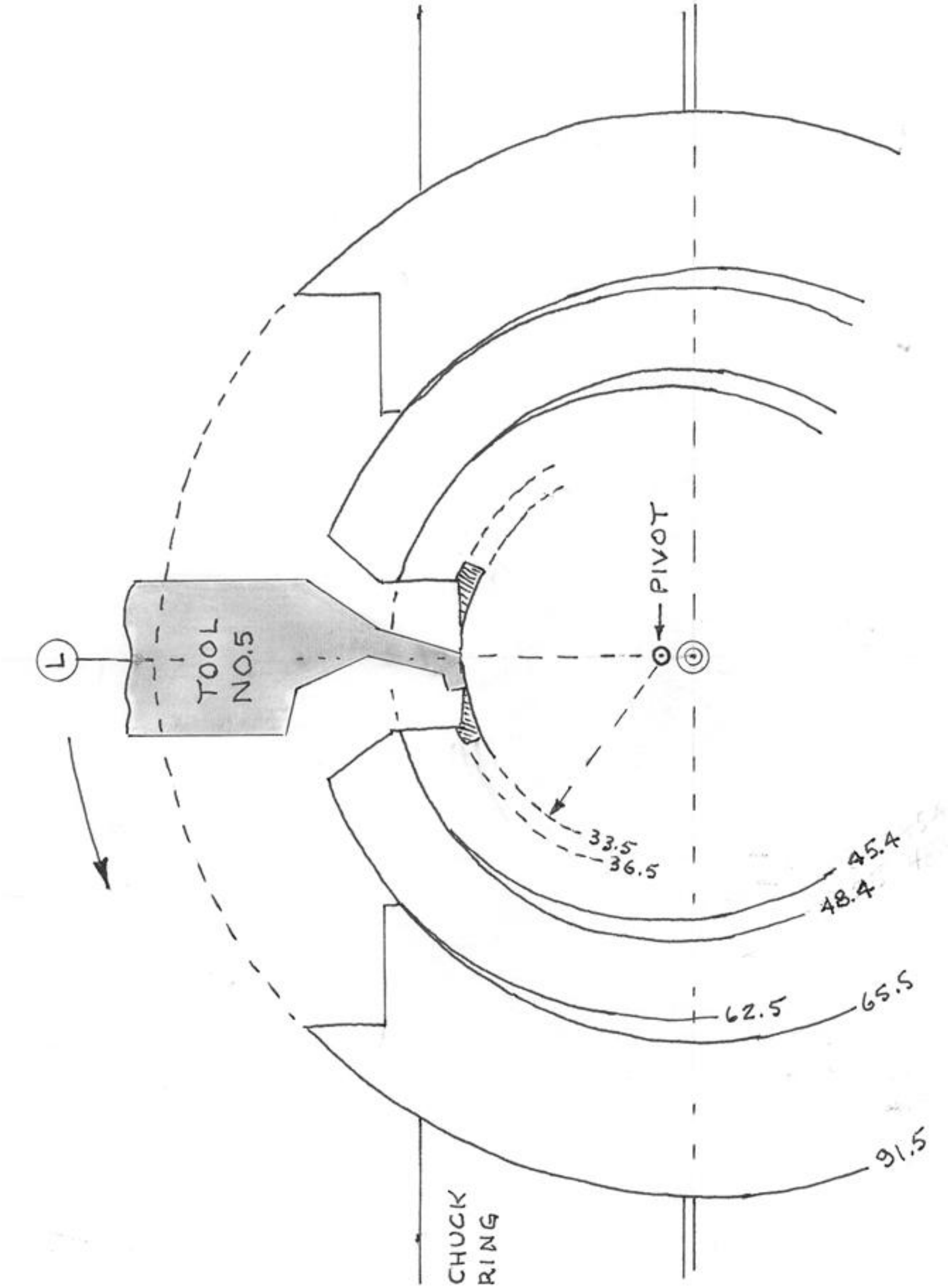
26. Mark 12 Ⓛ points and 20 Ⓢ points
 - Set a strip of anti-friction tape
 - Set jig pivot 45.4 from edge of sphere
 - Line up an Ⓛ point, push with rod and new block
 - Drill hole Ø25.4 depth 11.9
27. Cut hatched section with tool N°5
28. Cut hatched section with tool N°6
29. Cut hatched section with tool N°7 (instead of cap)
30. Wedge between R36.5 and R33.5
31. Loosen push rod and turn sphere to another Ⓛ point
32. Repeat items N°26 to 31 till all 12 faces are done.
 - Withdraw all wedges to free inside R45.4 sphere.

ITEM NO. 26

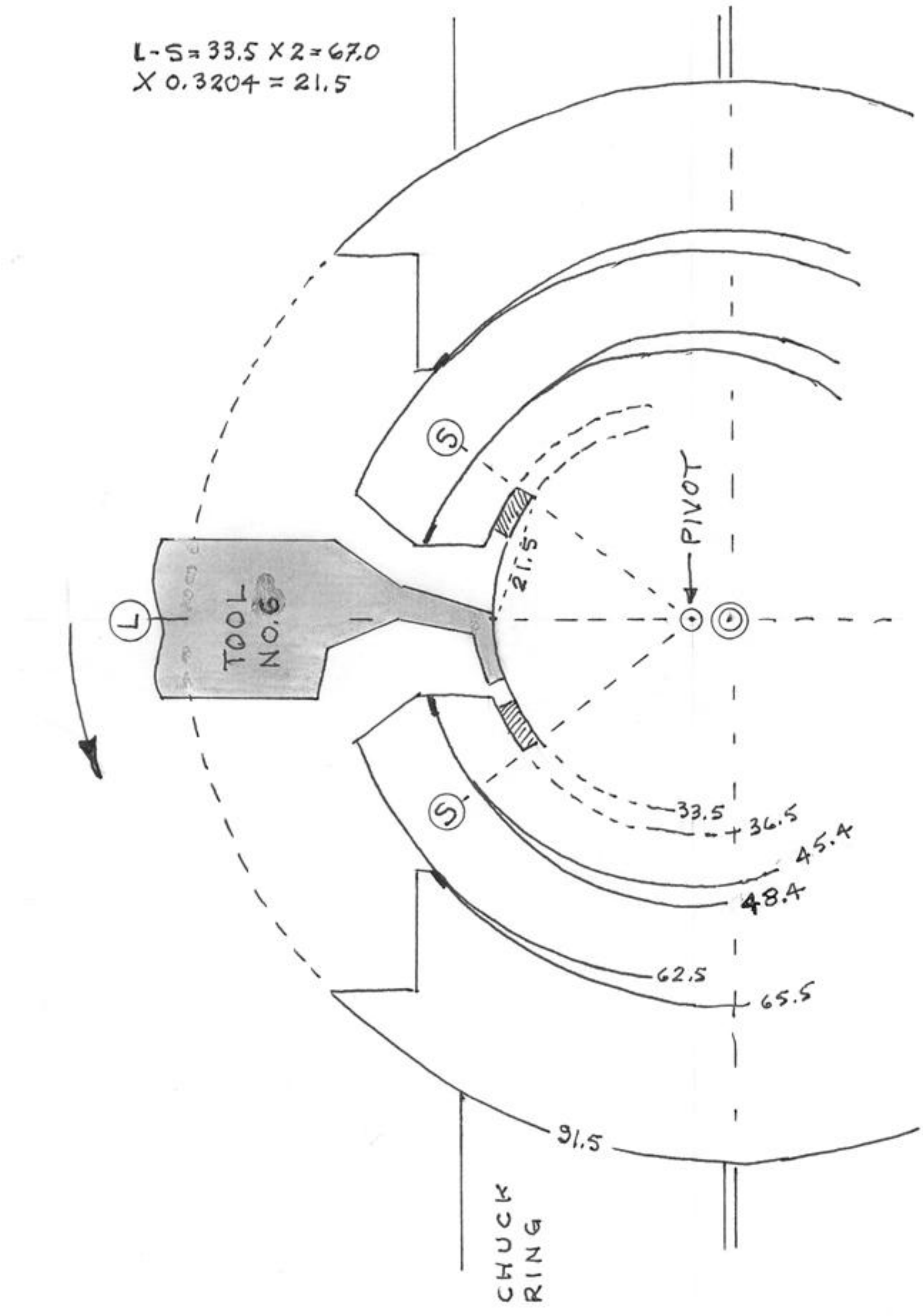


L
ANTI-FRICTION TAPE
11.9
25.4
33.5
65.5
62.5
45.4
48.4
91.5
PUSH BLOCK
PUSH ROD

ITEM NO. 27

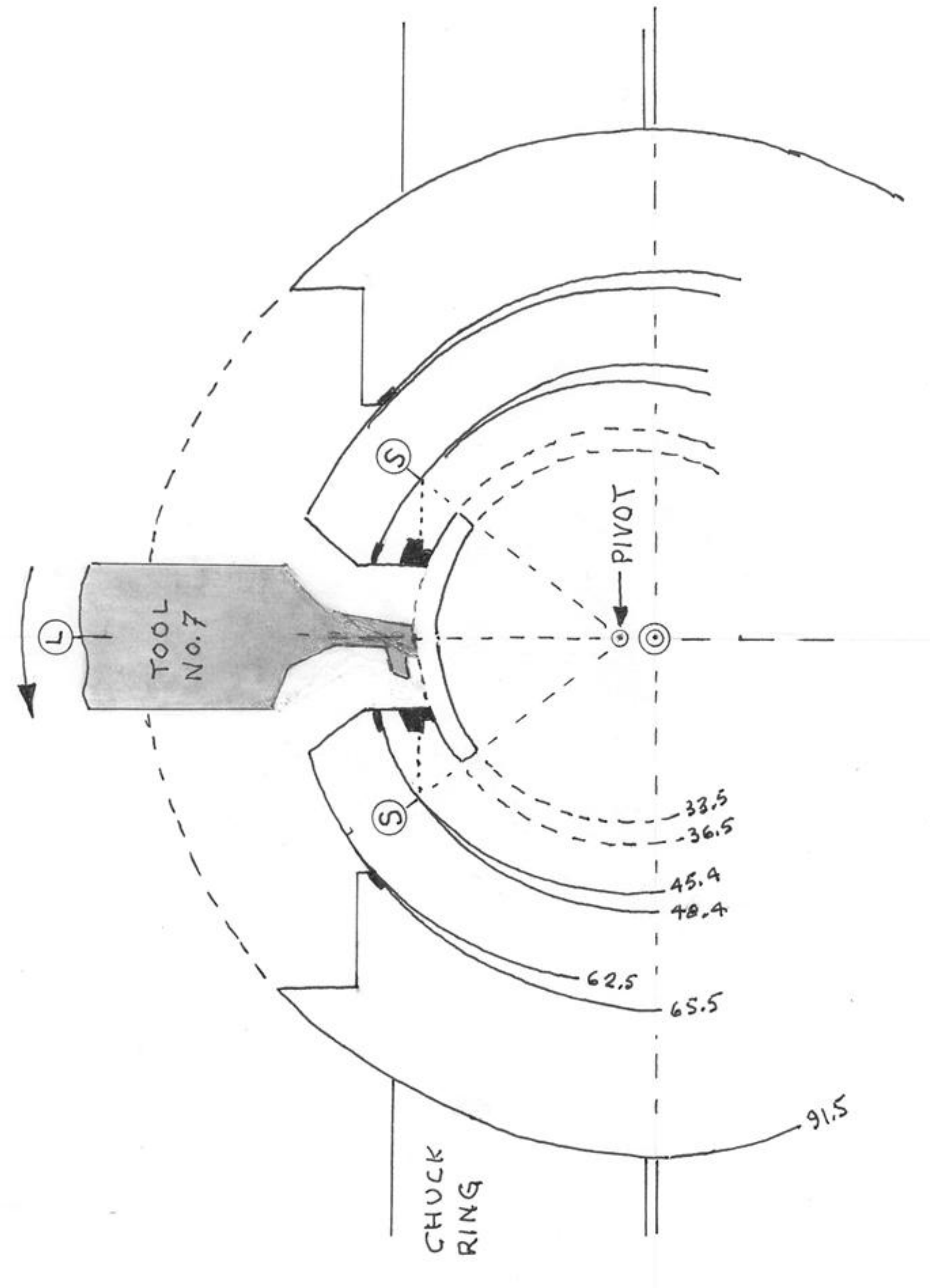


ITEM NO. 28

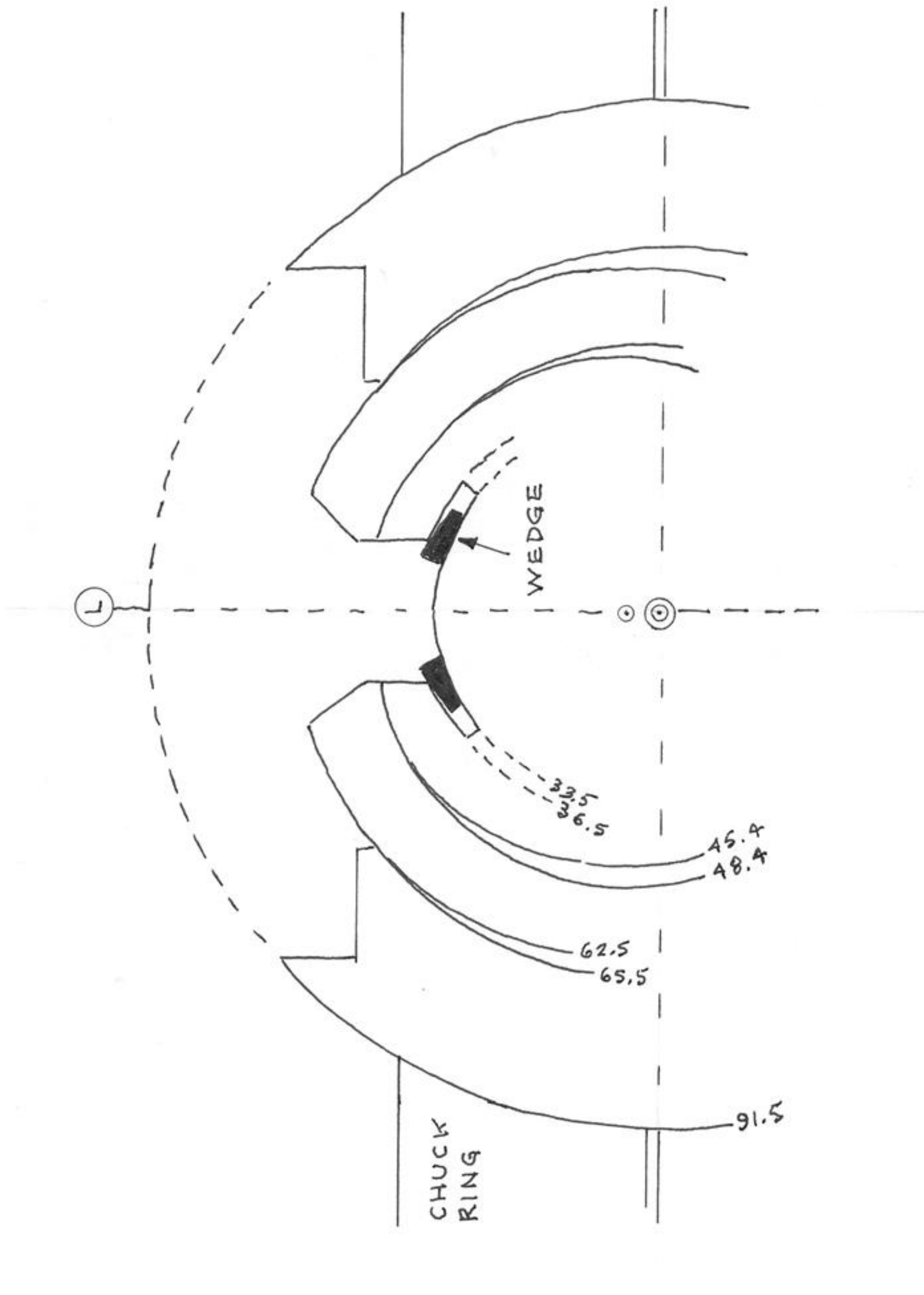


L - S = 33.5 X 2 = 67.0
X 0.3204 = 21.5
S
S
L
TOOL NO. 6
PIVOT
21.5
33.5
36.5
45.4
48.4
62.5
65.5
91.5
CHUCK RING

ITEM NO. 29



ITEM NO.30



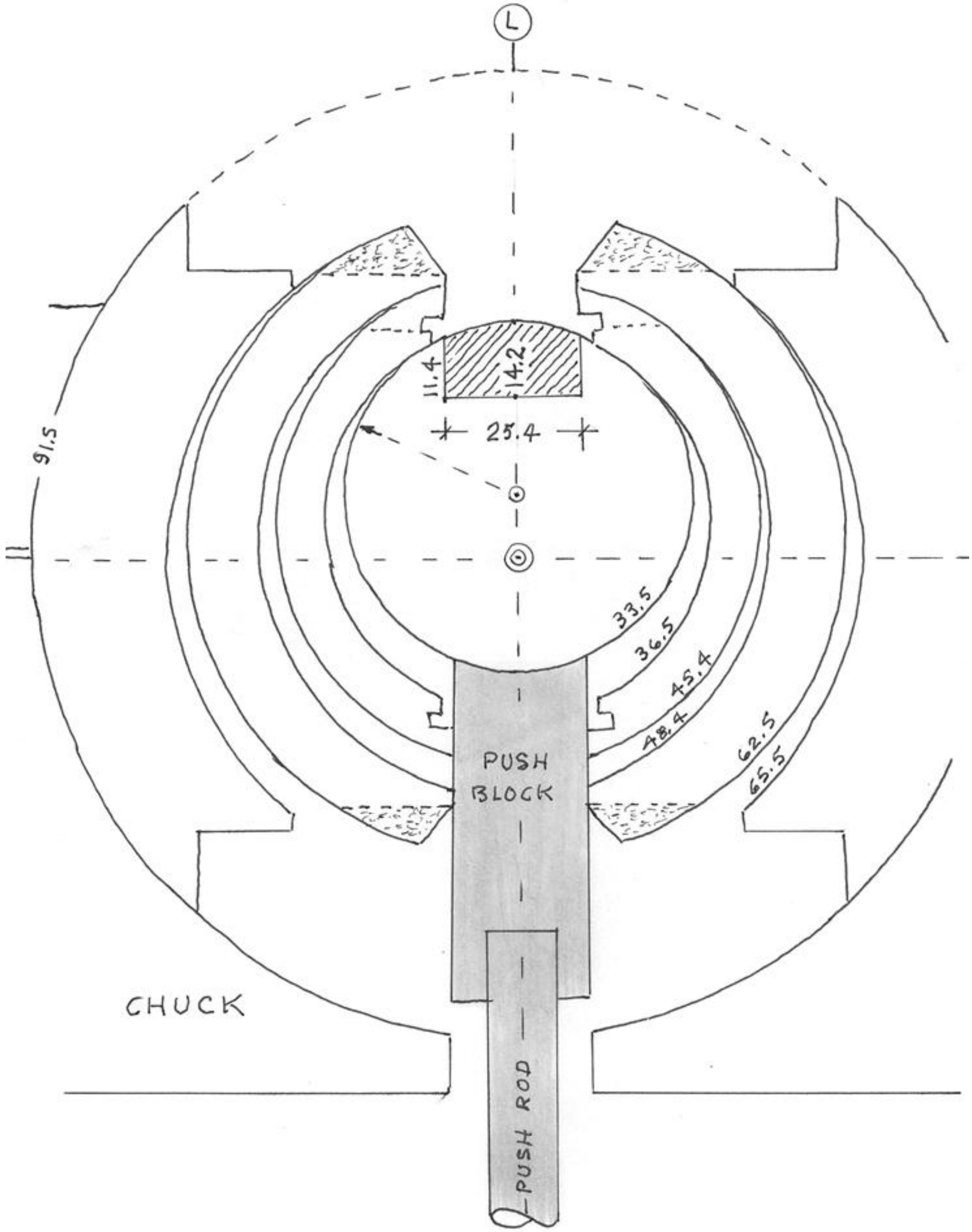
~ Sequence of operations ~

~ OCTAHEDRON ~

Item

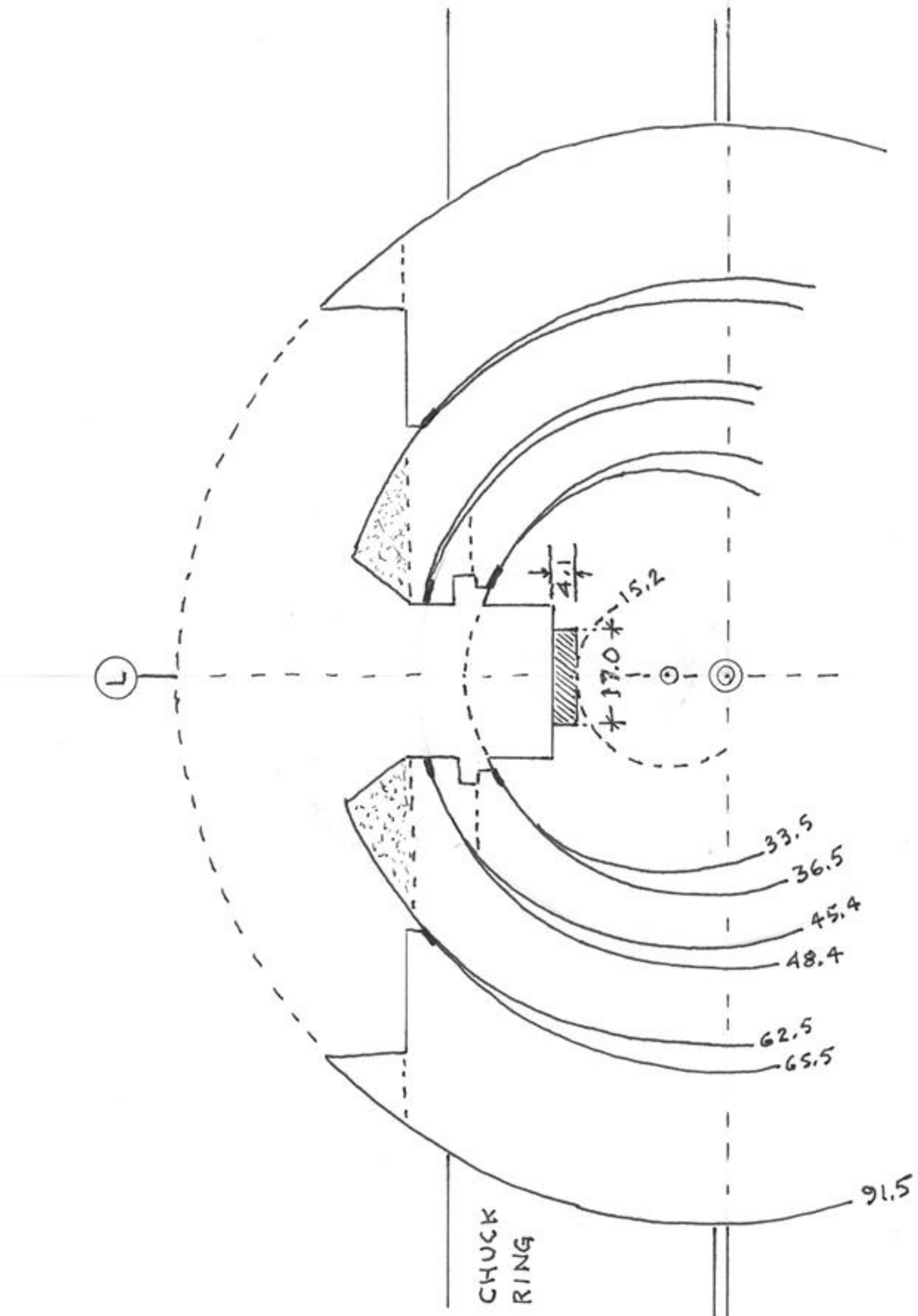
33. Mark 8 Ⓛ points and 6 Ⓢ points
  - Set a strip of anti-friction tape between R36.5 and R.33.5
  - Line up an Ⓛ point
  - Push R33.5 sphere tight against tape with push rod
  - Set pivot of sphere jig 33.5 from edge of sphere
  - Drill hole Ø25.4 depth 14.2 (11.4 from edge of sphere)
34. Drill hole Ø16.0 depth 4.1
35. Cut hatched section with tool N°8 (instead of cap)
36. Cut hatched section with tool N°9
37. Cut hatched section with tool N°10
38. Wedge between R15.2 and R18.2
39. Loosen push rod and turn sphere to another Ⓛ point.
  - Repeat items N°33 to 39 till all 8 faces are done.
  - Withdraw all wedges to free inside R45.4 sphere.

ITEM NO. 33

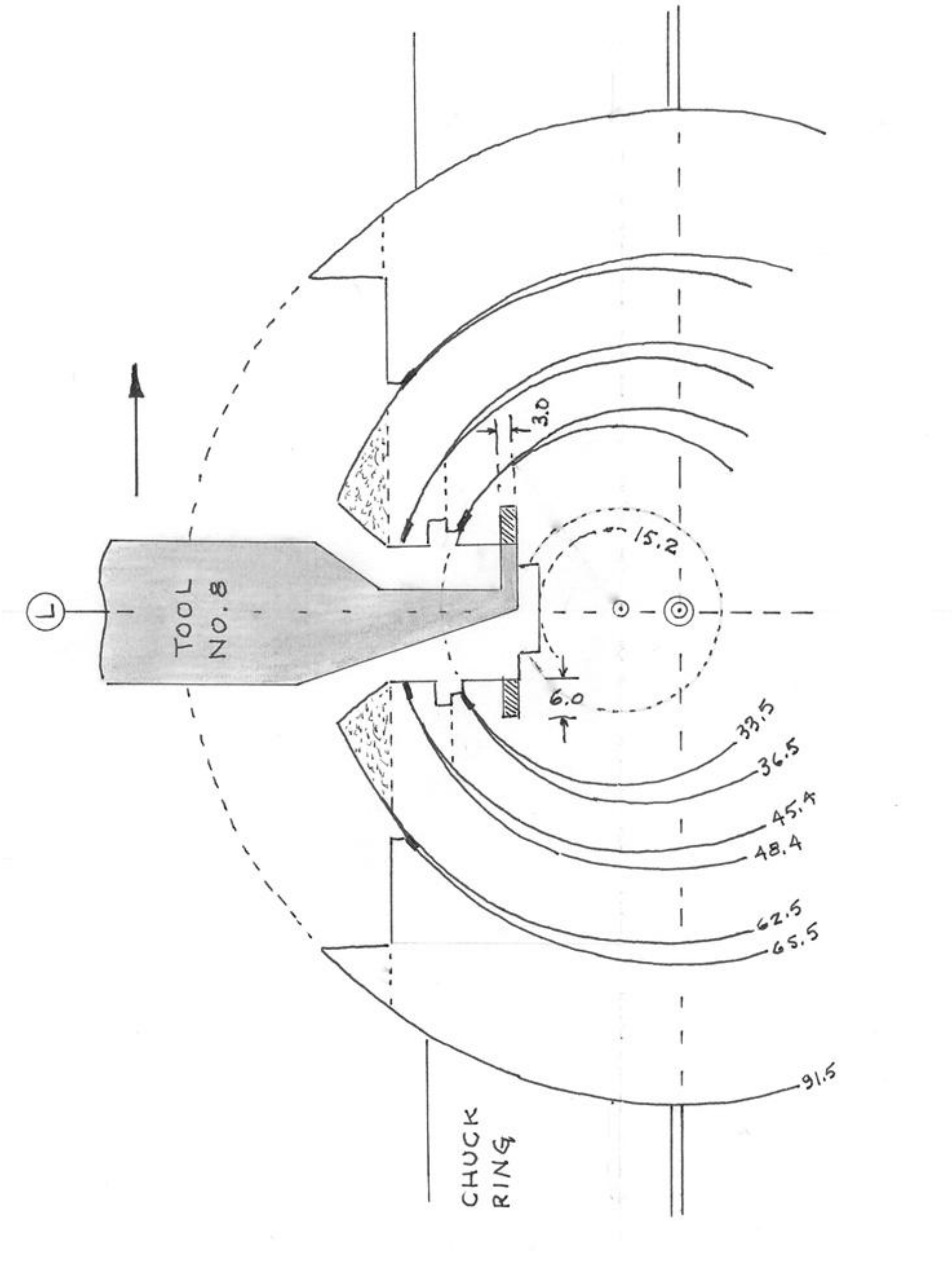


L
11.4
14.2
25.4
91.5
33.5
36.5
45.4
48.4
62.5
65.5
PUSH BLOCK
CHUCK
PUSH ROD

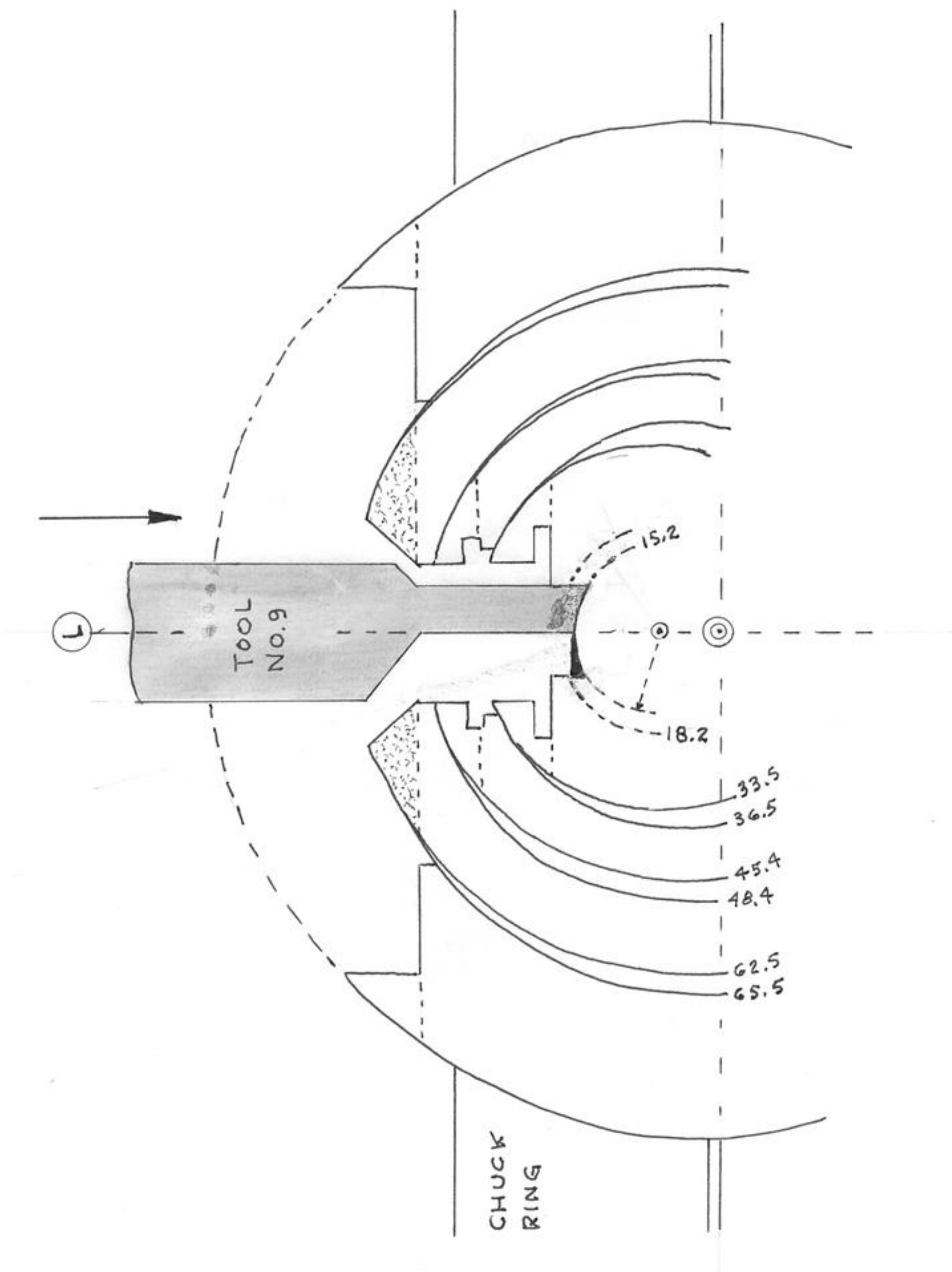
ITEM NO. 34



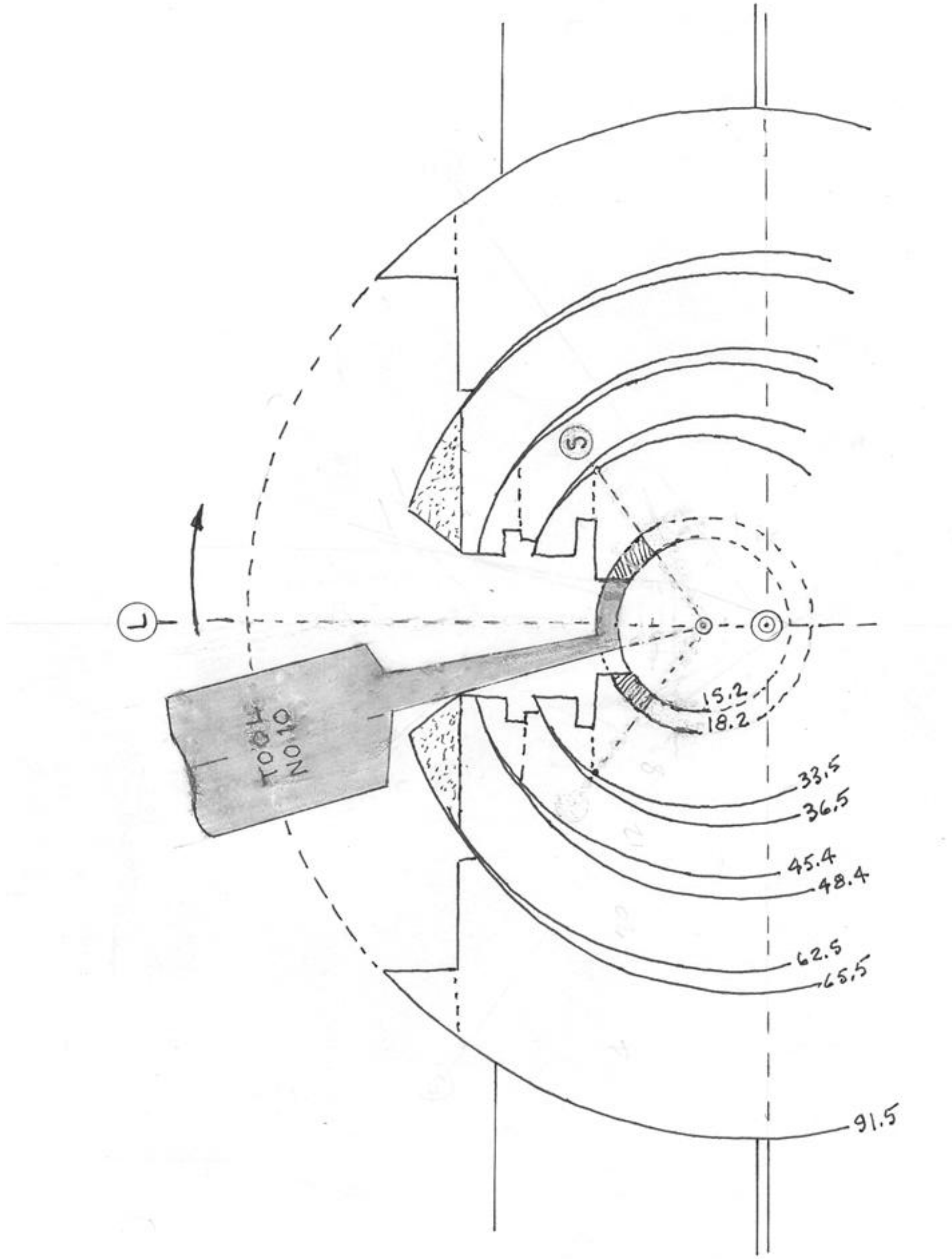
ITEM NO. 35



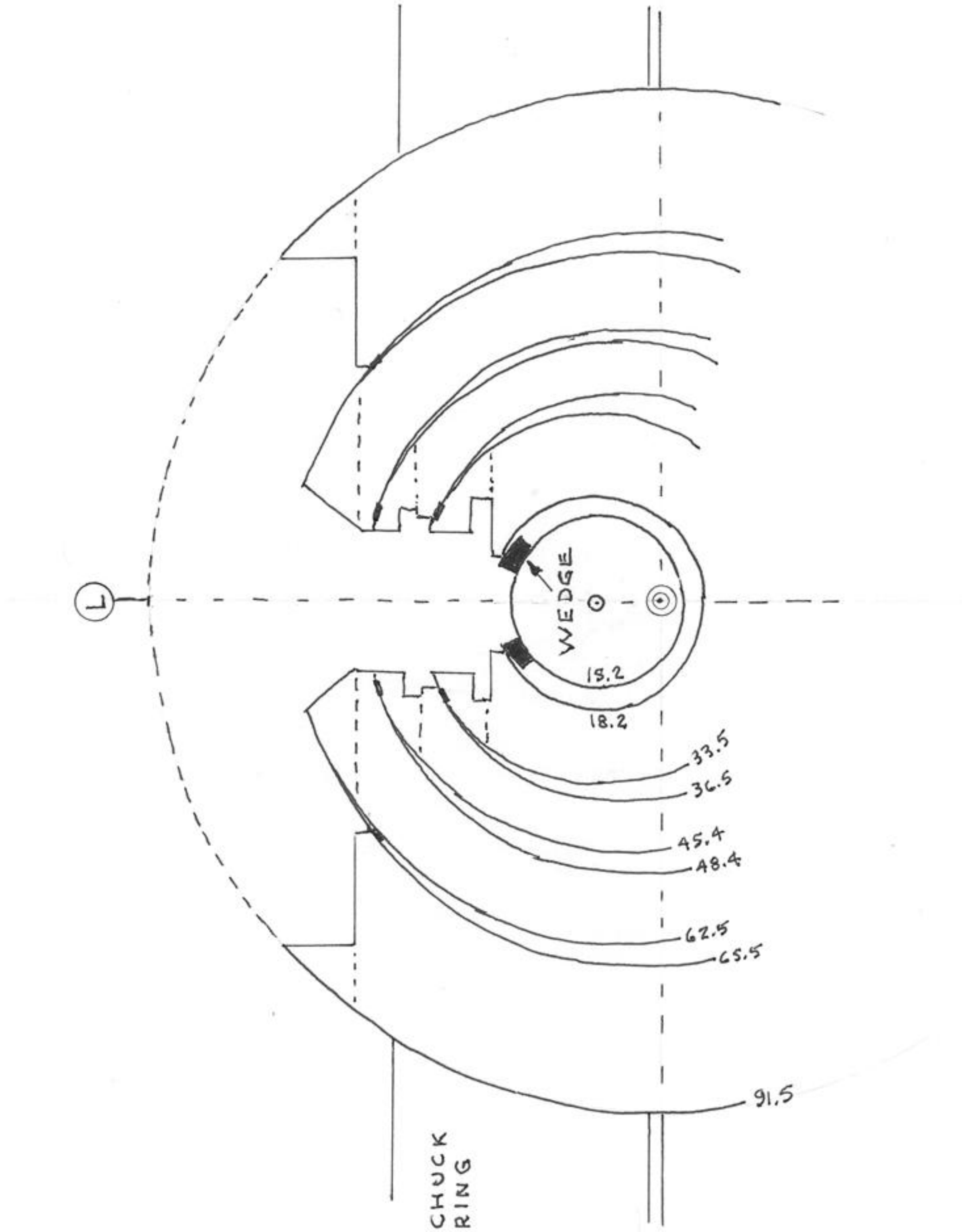
ITEM NO. 36



ITEM NO. 37



ITEM NO.38



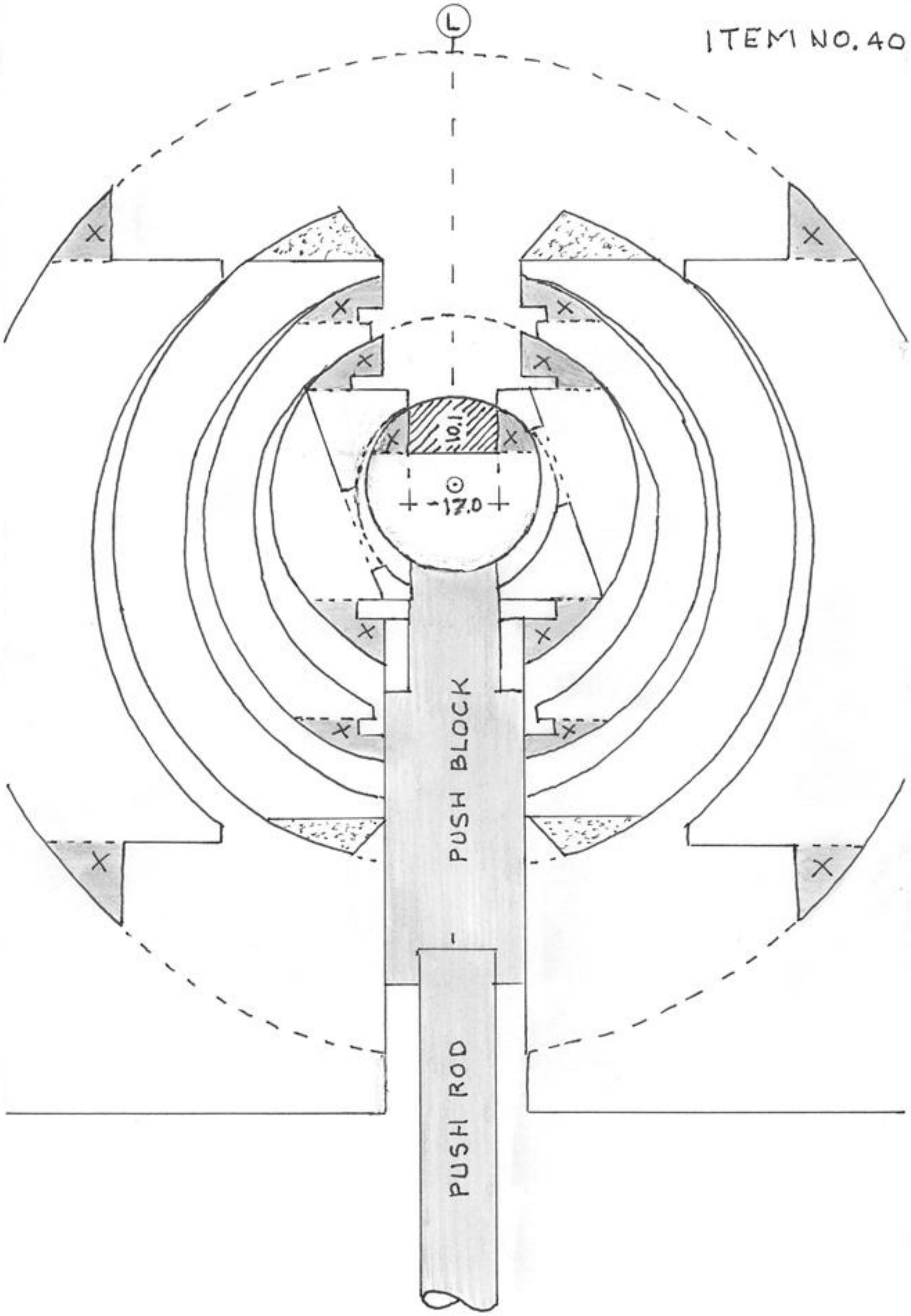
~ Sequence of operations ~

~ TETRAHEDRON ~

Item

40.

A. Mark 4 Ⓛ points
B. Set a strip of anti-friction tape
C. Line up an Ⓛ point
D. Push R15.2 sphere tight against tape with push rod
E. Drill hole Ø17.0 depth 10.1
F. Loosen push rod and turn sphere to another Ⓛ point.
G. Repeat items N°40C to 40G till all 4 faces are done
H. Remove cap on icosahedron
I. Cut solid portion marked x that was left in place instead of a cap on 4 remaining polyhedrons.

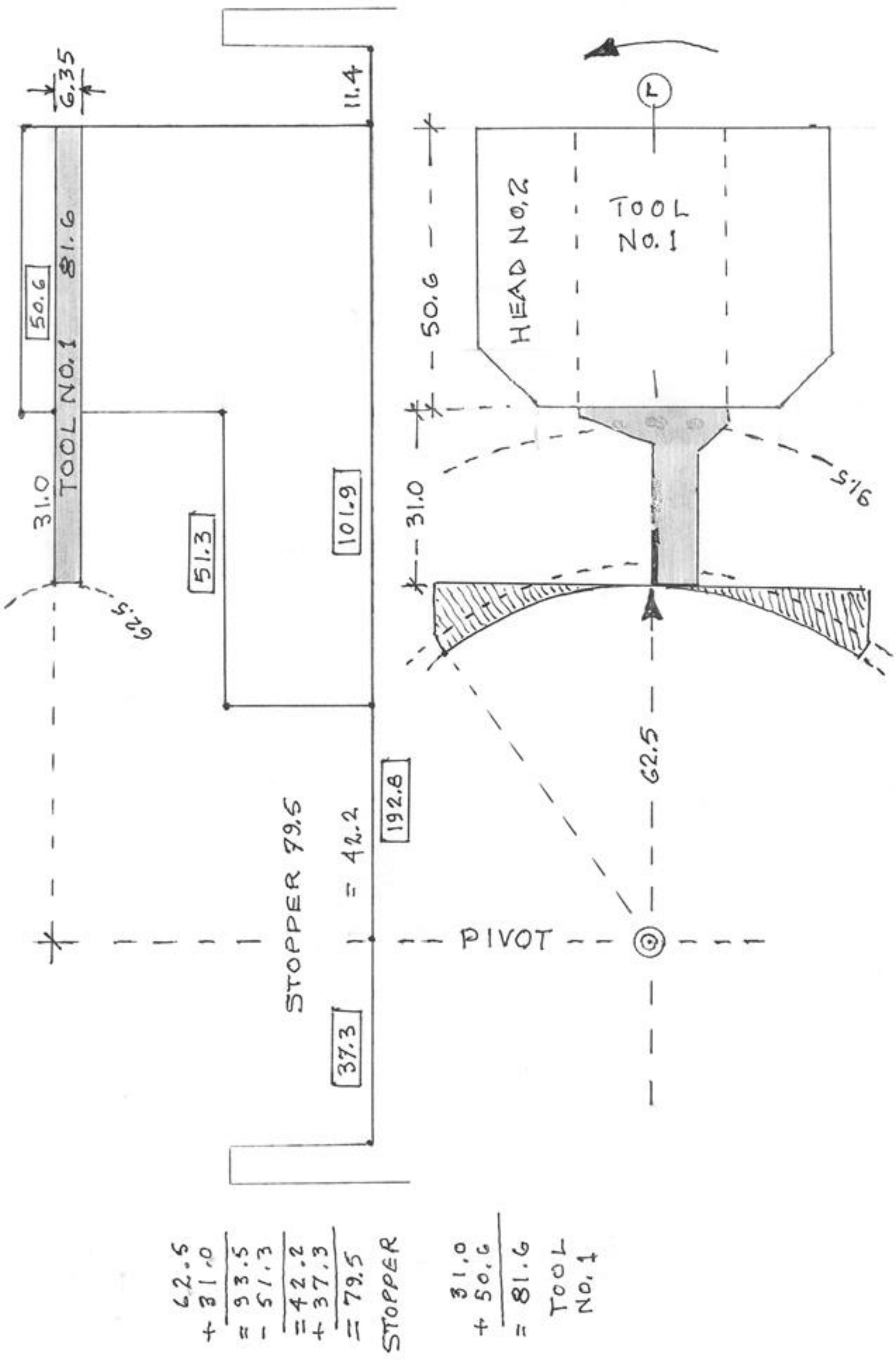


ITEM NO. 40
L
10.1
17.0
PUSH BLOCK
PUSH ROD

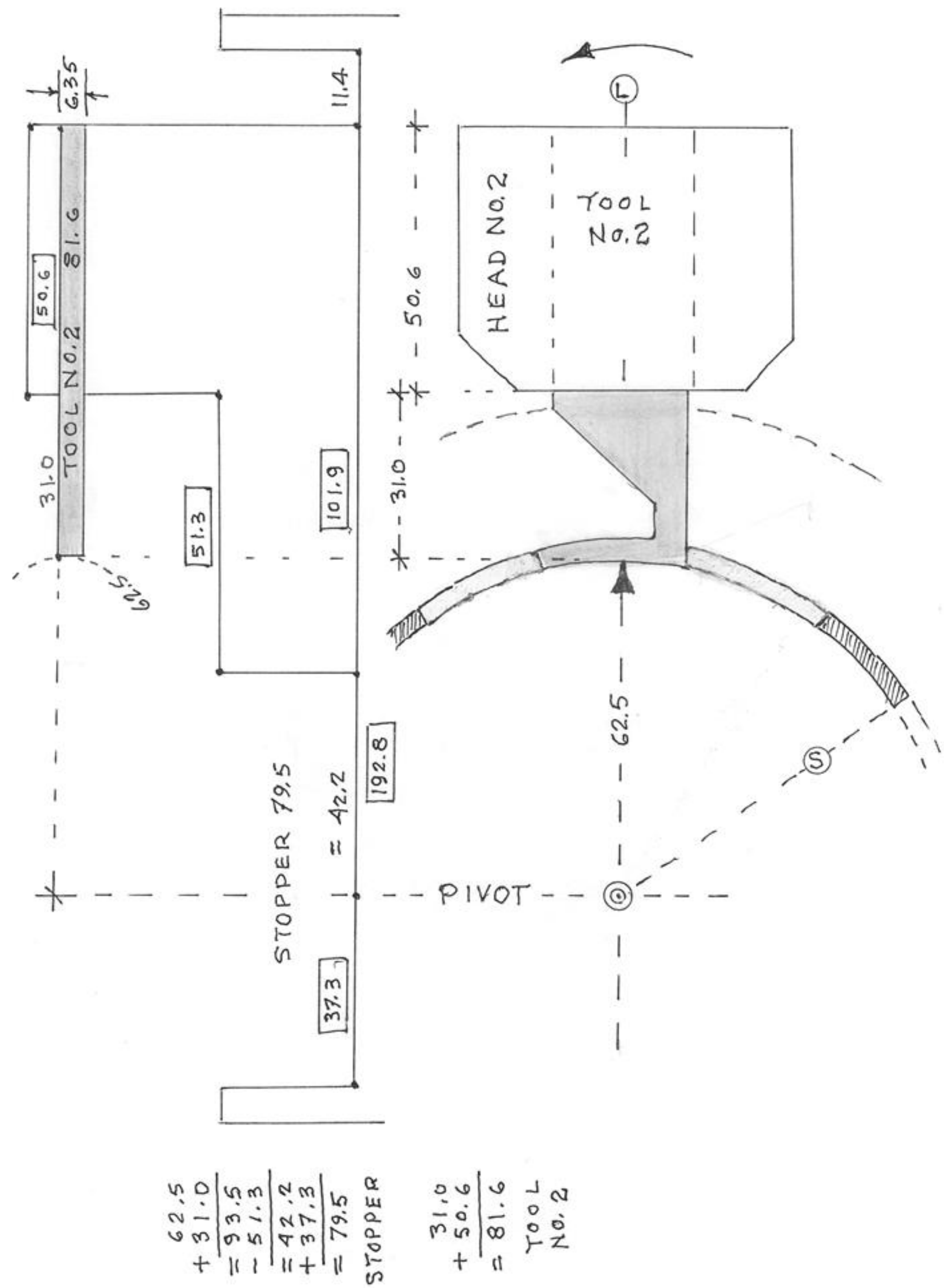
Details of tools N° 1 to 10

21- Form and dimensions.
22- Position of tool in sphere jig.
23- Position of sphere jig versus R.91.5 sphere.
24- Movement or rotation of sphere jig by arrow.
25- Note 1 : top edge of cutting end of tool to be at lathe center height.
26- Note 2 : except for the cutting end, the width of the tool inside the turning should be relieved so as not to rub on each side.
27- Note 3 : these tools are made for <u>my</u> sphere jig and for that <u>particular</u> turning only.
28- All distances in a rectangle are fixed dimensions of the sphere jig.
29- These drawings are rough hand drawings to approximate scale; they have to be re-drawn <u>very accurately</u> on the simulation plate with the appropriate part of the cross-section.
30- For the rough cutting of the tools use the <u>dimensions</u> of the rough drawings, do not trace over.

ITEM NO.41

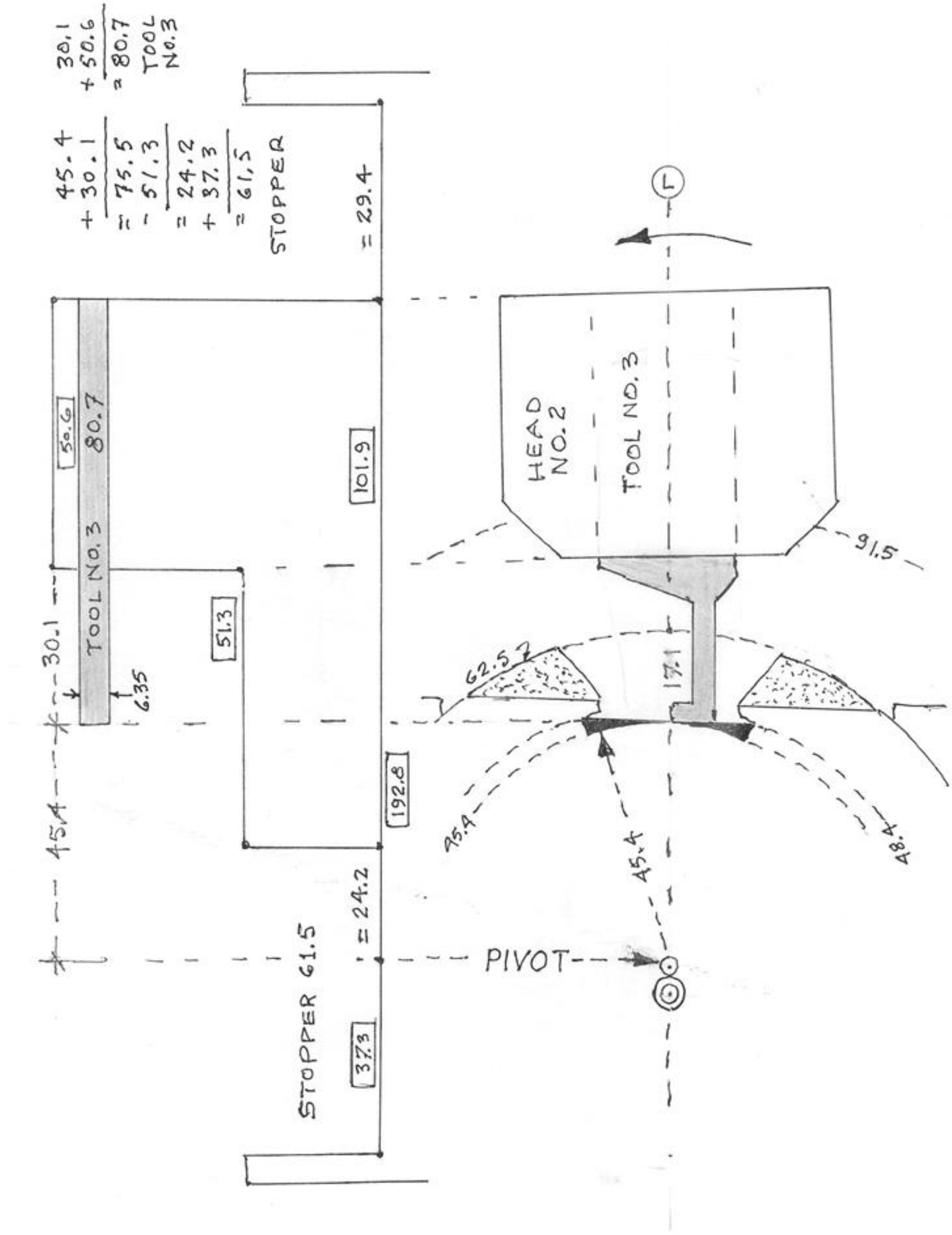

6.35
11.4
TOOL NO.1
81.6
50.6
31.0
62.5
51.3
101.9
192.8
STOPPER 79.5
= 42.2
37.3
PIVOT
HEAD NO.2
TOOL
No.1
50.6
31.0
62.5
51.6
62.5
+ 31.0
= 93.5
- 51.3
= 42.2
+ 37.3
= 79.5
STOPPER
31.0
+ 50.6
= 81.6
TOOL
No.1

ITEM NO. 42

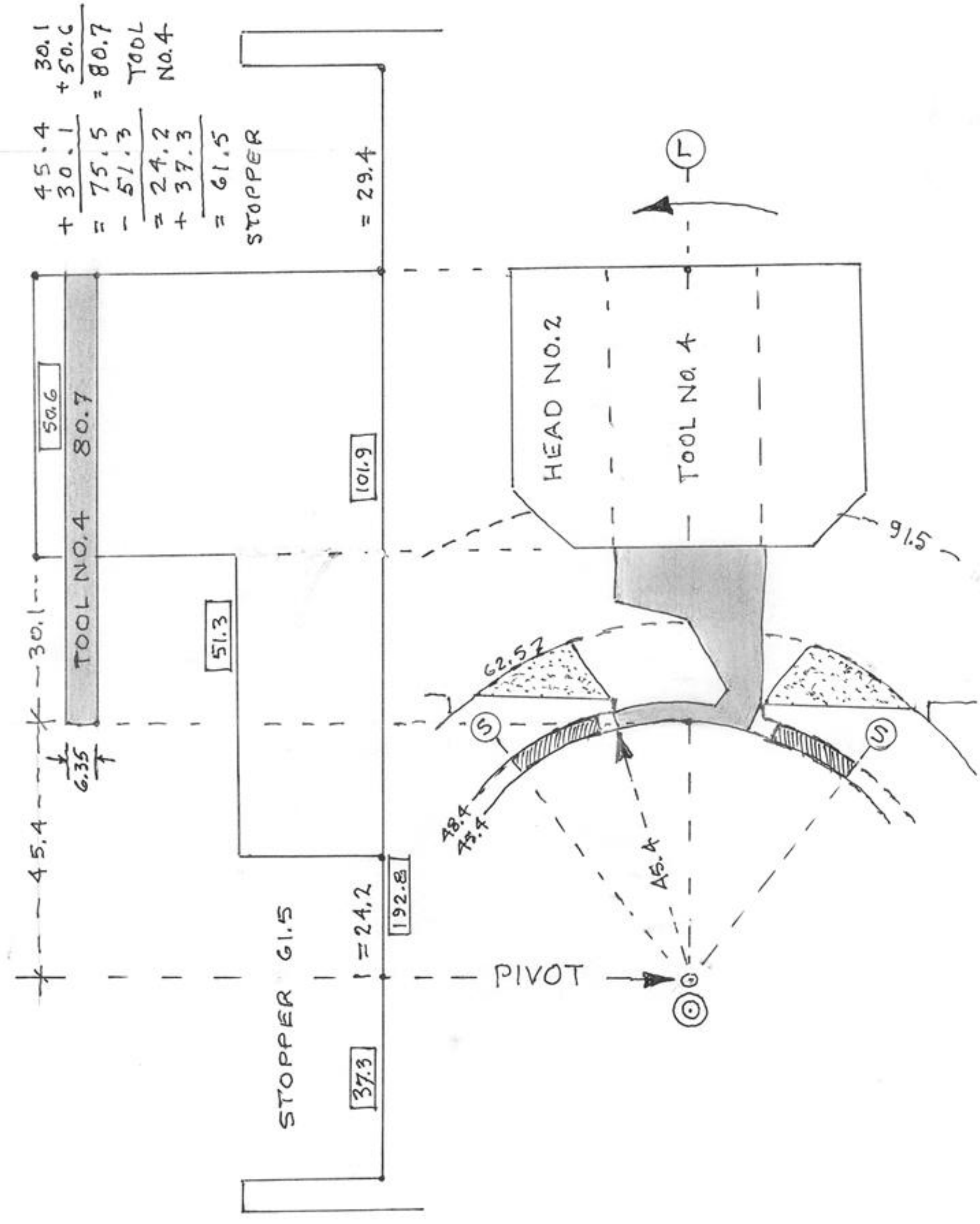


6.35
11.4
L
HEAD NO.2
TOOL No.2
50.6
81.6
TOOL NO.2
31.0
51.3
101.9
62.5
192.8
STOPPER 79.5
= 42.2
PIVOT
S
37.3
62.5
+ 31.0
= 93.5
− 51.3
= 42.2
+ 37.3
= 79.5
STOPPER
31.0
+ 50.6
= 81.6
TOOL No. 2

ITEM NO. 43

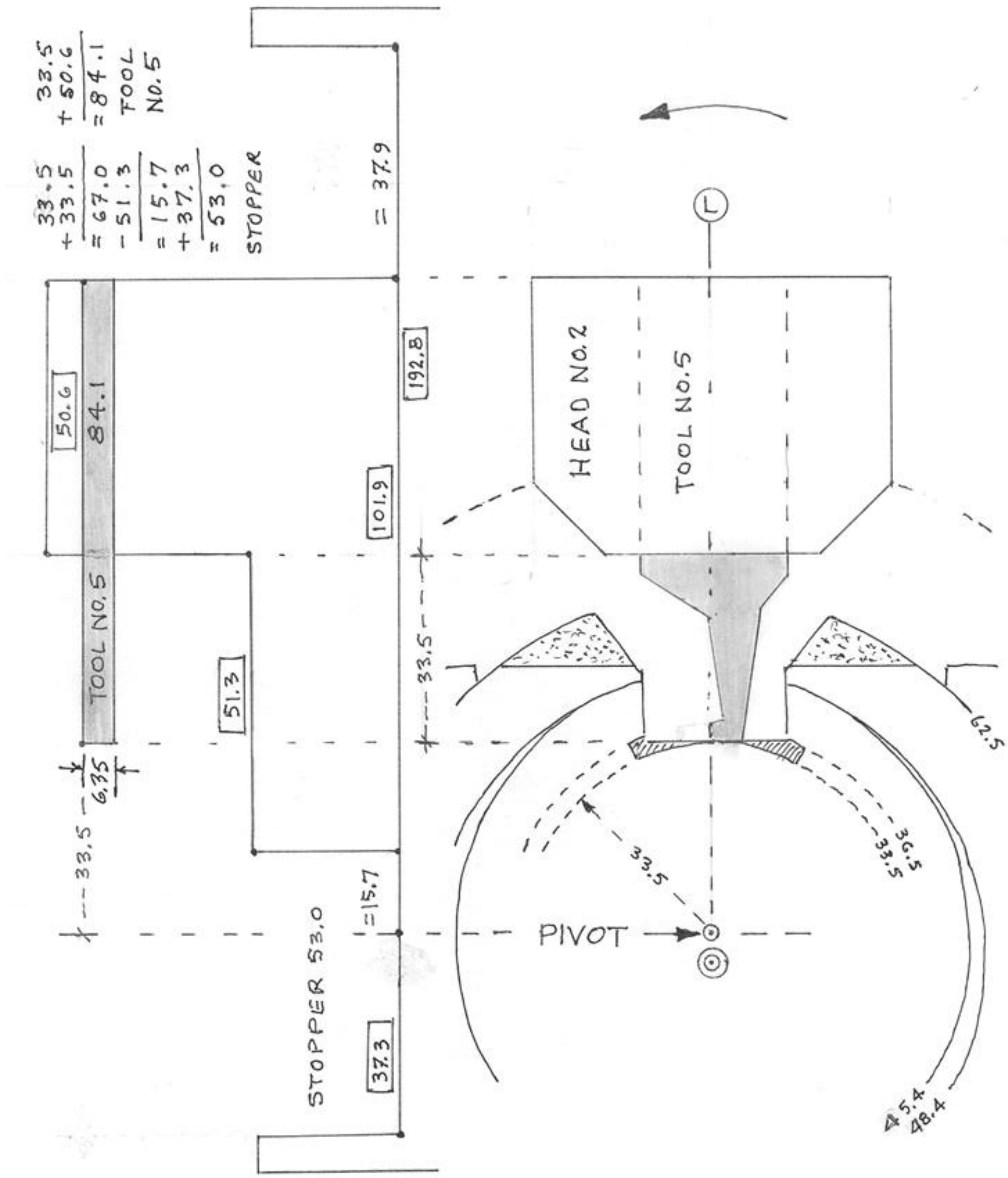

45.4
+ 30.1
= 75.5
- 51.3
= 24.2
+ 37.3
= 61.5
STOPPER
30.1
+ 50.6
= 80.7
TOOL NO.3
= 29.4
HEAD NO.2
TOOL NO.3
50.6
80.7
101.9
91.5
TOOL NO.3
30.1
6.35
51.3
62.5
17.1
45.4
192.8
45.4
45.4
48.4
= 24.2
STOPPER 61.5
PIVOT
37.3

ITEM NO. 44

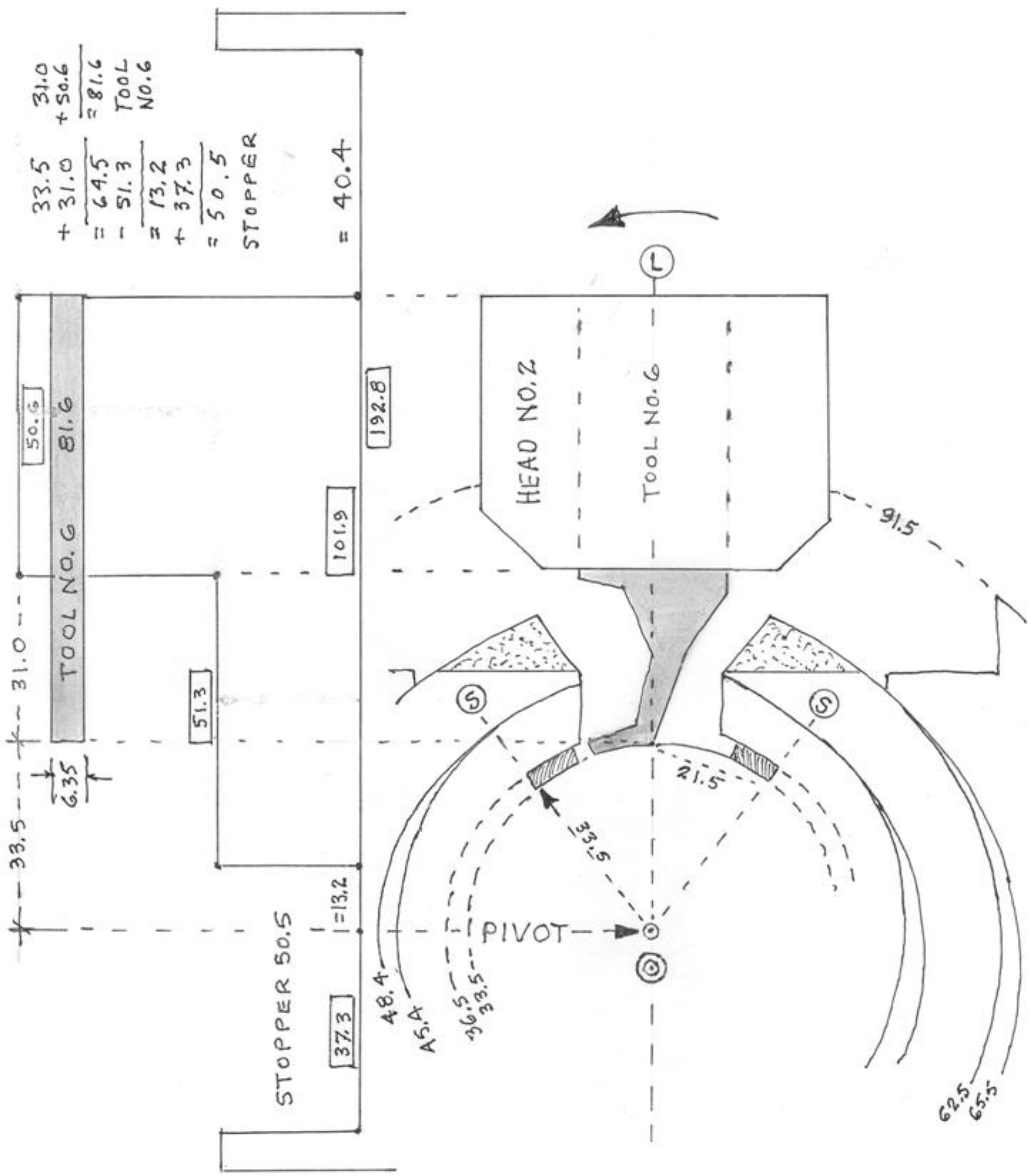


+ 45.4
30.1
= 75.5
− 51.3
= 24.2
+ 37.3
= 61.5
STOPPER
30.1
+ 50.6
= 80.7
TOOL NO.4
= 29.4
HEAD NO.2
TOOL No. 4
TOOL NO.4
80.7
50.6
101.9
51.3
30.1
45.4
6.35
91.5
62.57
48.4
45.4
45.4
S
S
L
STOPPER 61.5
= 24.2
192.8
37.3
PIVOT

ITEM NO. 45

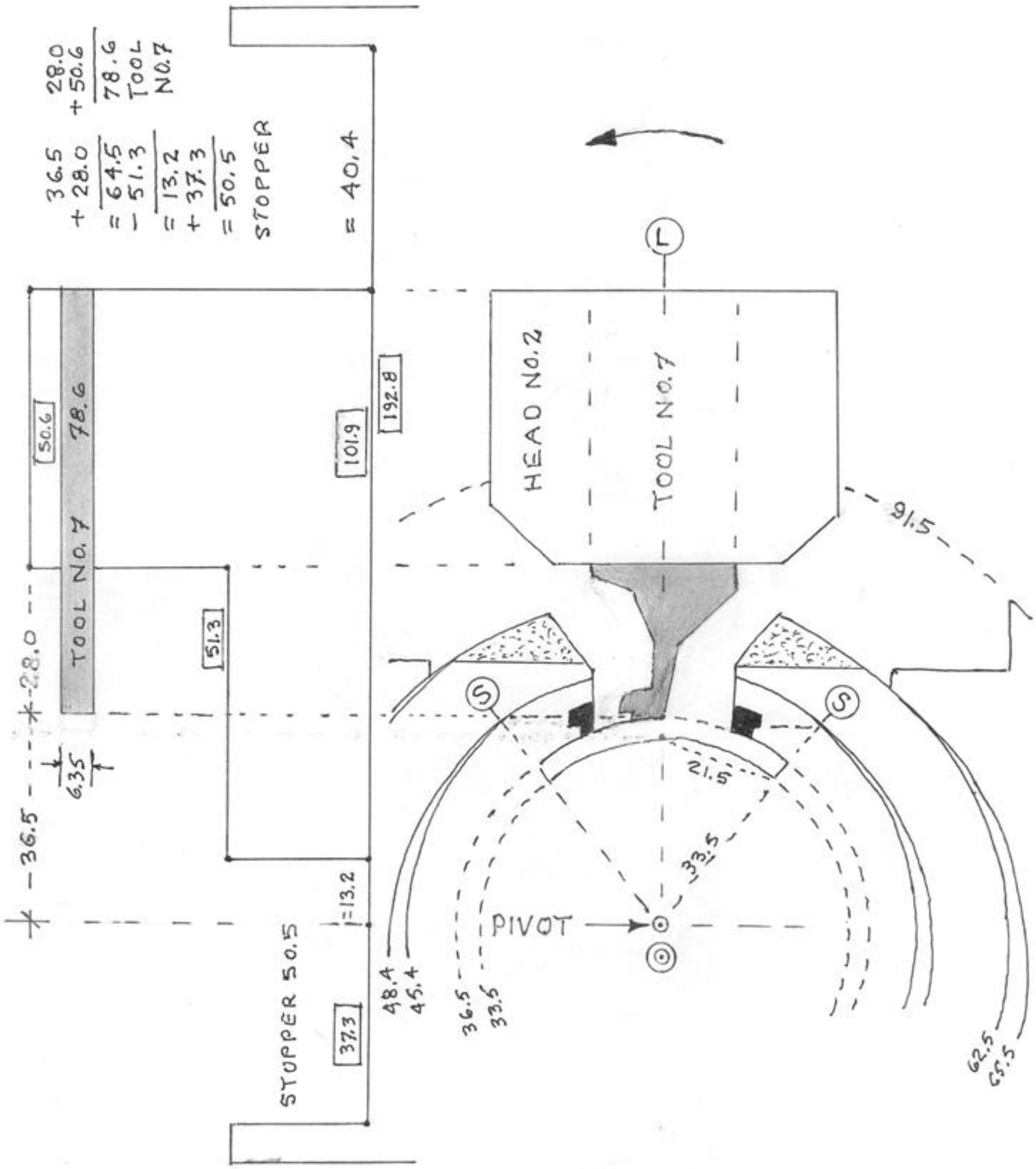

33.5
+ 33.5
= 67.0
− 51.3
= 15.7
+ 37.3
= 53.0
STOPPER
33.5
+ 50.6
= 84.1
TOOL
NO.5
= 37.9
50.6
84.1
TOOL NO.5
192.8
101.9
51.3
33.5
6.35
=15.7
STOPPER 53.0
37.3
HEAD NO.2
TOOL NO.5
L
PIVOT
33.5
36.5
33.5
62.5
45.4
48.4

ITEM NO. 46

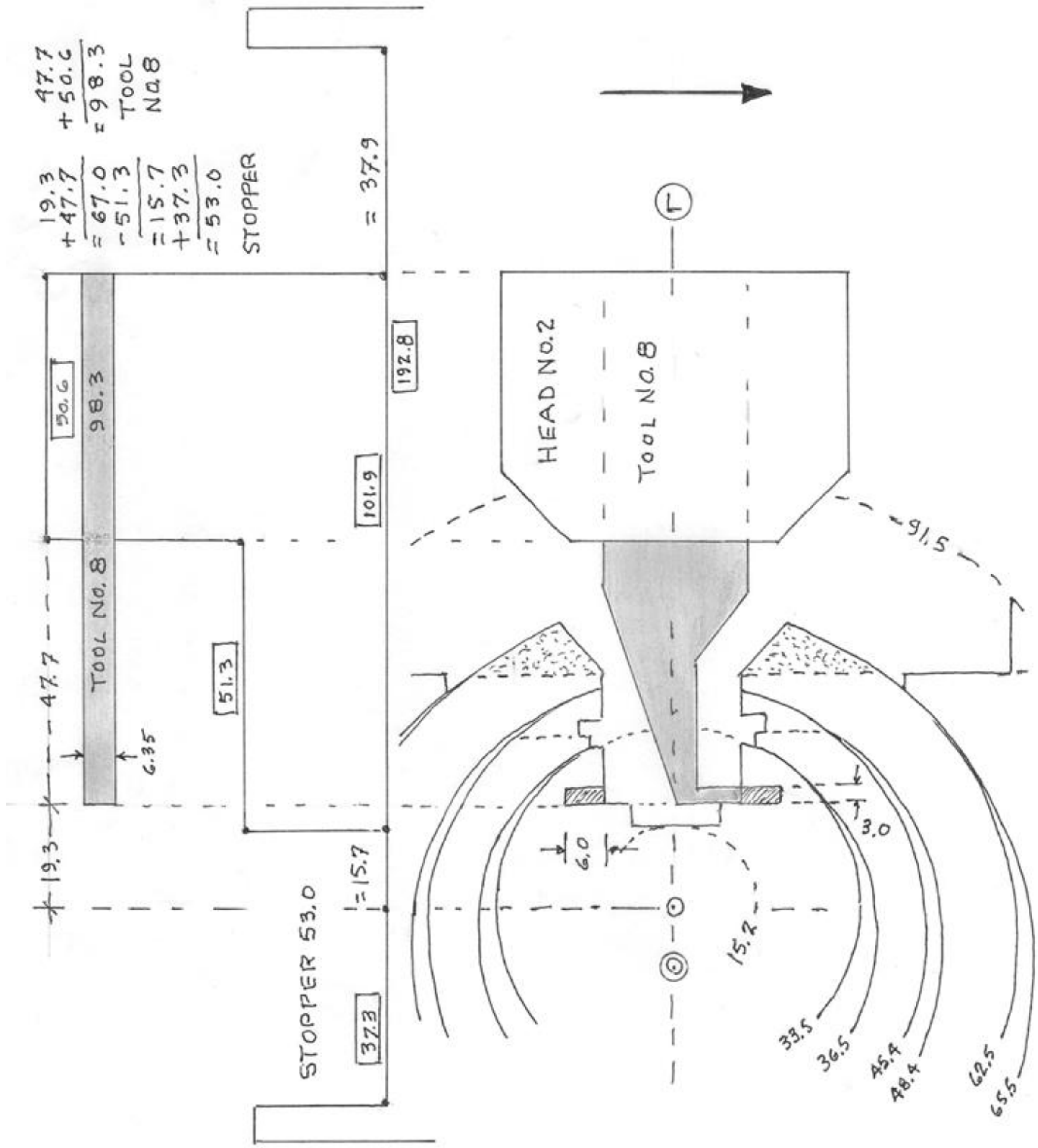


33.5
+ 31.0
= 64.5
− 51.3
= 13.2
+ 37.3
= 50.5
STOPPER
31.0
+ 50.6
= 81.6
TOOL NO.6
= 40.4
L
HEAD NO.2
TOOL NO.6
50.6
81.6
TOOL NO.6
192.8
101.9
91.5
31.0
51.3
S
S
21.5
33.5
6.35
33.5
=13.2
PIVOT
STOPPER 50.5
37.3
48.4
45.4
36.5
33.5
62.5
65.5

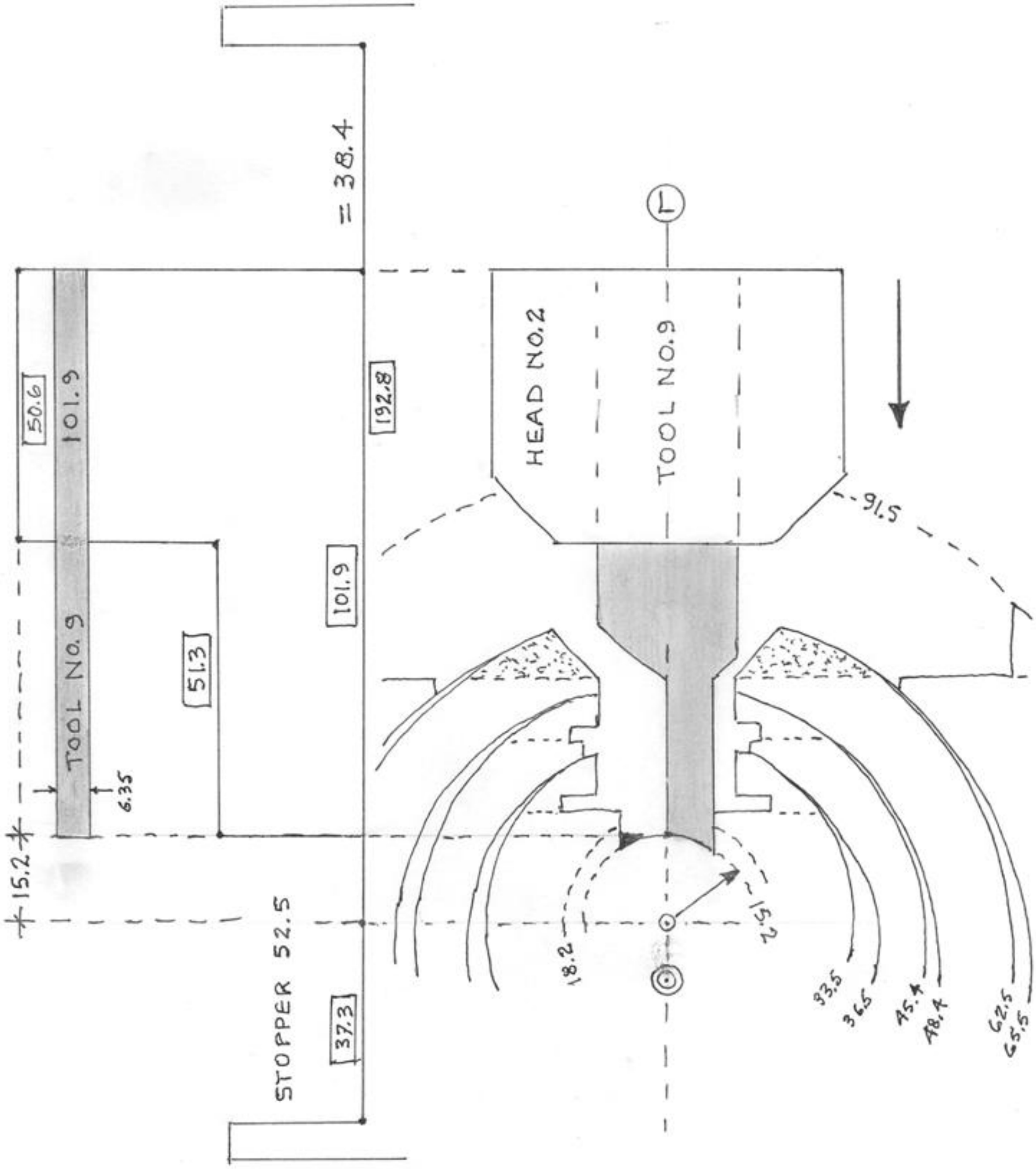
ITEM NO. 47


36.5
+ 28.0
= 64.5
− 51.3
= 13.2
+ 37.3
= 50.5
STOPPER
= 40.4
28.0
+ 50.6
78.6
TOOL
NO.7
L
HEAD NO.2
TOOL NO.7
91.5
50.6
78.6
TOOL NO.7
101.9
192.8
51.3
28.0
36.5
6.35
S
S
21.5
33.5
PIVOT
13.2
STOPPER 50.5
37.3
48.4
45.4
36.5
33.5
62.5
65.5

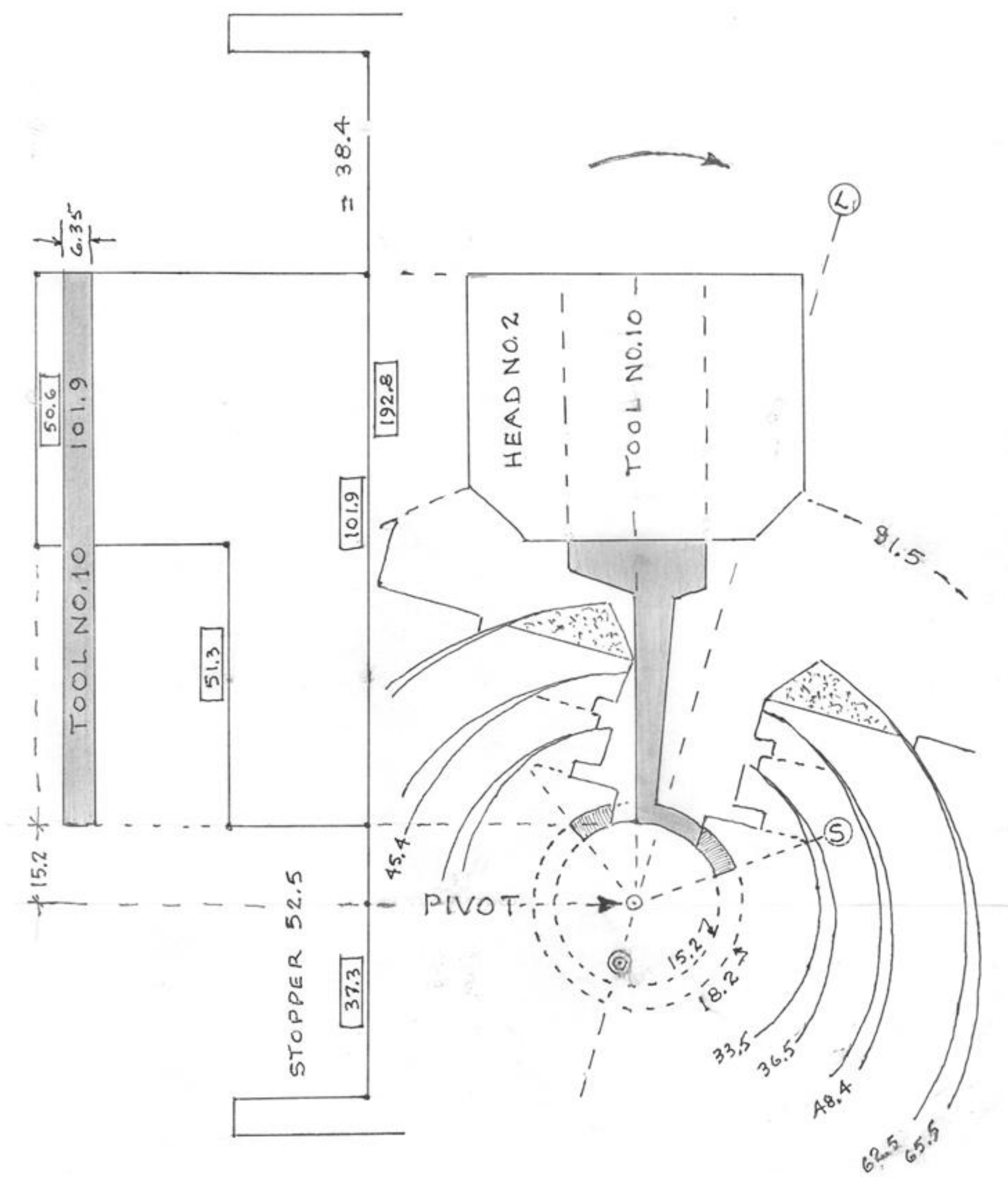
ITEM NO. 48


19.3
+47.7
=67.0
-51.3
=15.7
+37.3
=53.0
STOPPER
47.7
+50.6
=98.3
TOOL
NO.8
= 37.9
HEAD NO.2
TOOL NO.8
50.6
98.3
192.8
101.9
TOOL NO.8
47.7
6.35
51.3
19.3
=15.7
STOPPER 53.0
37.3
91.5
3.0
6.0
15.2
33.5
36.5
45.4
48.4
62.5
65.5

ITEM NO. 49


HEAD NO.2
TOOL NO.9
TOOL NO.9
= 38.4
192.8
101.9
50.6
101.9
51.3
6.35
15.2
STOPPER 52.5
37.3
91.5
18.2
15.2
33.5
36.5
45.4
48.4
62.5
65.5

ITEM NO. 50


HEAD NO.2
TOOL NO.10
TOOL NO.10
PIVOT
STOPPER 52.5
6.35
50.6
101.9
192.8
101.9
51.3
37.3
15.2
≅ 38.4
81.5
45.4
15.2
18.2
33.5
36.5
48.4
62.5
65.5
L
S