Comparison of Improved Stoves: Lab, Controlled Cooking, and Family Compound Tests

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Ouagadougou, Upper Volta

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Foreword

This is the third in a series of field reports on the work done by the CILSS/VITA Regional Woodstoves Technical Coordinator and collaborators. These are not polished, final reports but rather represent an attempt to get research results into the field quickly in order to aid other ongoing work and to stimulate debate.

This third report is the first in the series to include controlled cooking tests and stove tests in family compounds. This permits a statistical correlation of cooking test results with lab testing of stoves, indicating whether laboratory testing truly shows the most efficient stoves in actual use.

In this report, also, an analysis of open fires (three stone stoves) indicates a wide range of efficiency values based on a number of variables. An important aspect of this analysis is the finding that the efficiencies of three stone fires in a protected area are much higher than usually reported.

The report concludes that chimneyless stoves perform better than those tested with chimneys; that the thermal performance of a three stone fire is higher than normally quoted; and that multi-pot, massive stoves (with the exception of one stove tested) are equal to or less than the efficiency of the open fire. Lightweight, chimneyless stoves show the highest thermal efficiences of the stoves tested.

Many thanks go to all those who helped in constructing the stoves, testing them, and providing support throughout this work. In particular,

For stove construction: Association Internationale de Développement Rural; Centre d'Artisans Handicappés; Foyers Modernes de Kaya; Mission Forestière d'Allemande; Volontaires du Progrès, Titao.

For stove testing: Isabelle Dabone, Leocadie Samandoulougou, Alice Yaro, and Tene Zizien.

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I. INTRODUCTION AND SUMMARY

A major effort to test the performance of various improved stoves has begun at the Voltaic Institute of Energy with technical assistance from Eindhoven University, GTZ, and the CILSS/VITA Technical Coordinator. The testing reported here included:

- High power water boiling tests;
- Controlled cooking tests;
- Heat recuperation tests; and
- High power water boiling tests in family compounds.

The following is a summary of the results to date.

High Power Water Boiling Tests

Thirteen different stoves were tested using high power water boiling tests. The stoves were built by the same masons who build that particular type of stove in the field. All stoves used #3 aluminum pots except the Nouna 31, and the third potholes of the Kaya 3 and the AIDR 3 stoves which needed #4 pots. The same species of wood, Eucalyptus camaldulensis, having a moisture content of 6%, was used in all tests. All tests were done side by side in the same hangar using the same balance, accurate to 1 gram over 7 kg, and the same thermometers.

The procedure used was to bring the first pot to a boil, and then simmer it for one hour. Since no covers were used on the pots at any time, the firepower required throughout the tests (even during simmering) remained high. Wood and water weights were recorded before the test began, when the first pot reached the boiling point, and after the one-hour simmering phase was completed. Charcoal was recovered and weighed at the end of the simmering phase. Water temperatures were recorded every five minutes throughout the entire test.

The thermal efficiency of each pot (or percent heat utilized - PHU) was then calculated in two ways. The first calculation did not include the weight of the charcoal remaining at the end of the test since it is not at all clear that in practice this charcoal is consistently extinguished and saved for later use. Thus, not taking the remaining charcoal into account gives:

$$PHU = \frac{4.186MT + 2,260E}{17,150W} \times 100\%$$

where 4.186 is the specific heat of water, kJ/kg, M is the initial mass of water, T is the temperature change of the water, 2260 kJ/kg is the latent heat of vaporization of water, and E is the quantity of water evaporated. W is the mass of wood burned during the test and 17,150 kJ/kg is its calorific heat. (It must be noted that the calorific value 17,150 kJ/kg is the corrected value considering moisture content. Previous reports, Yameogo, June 1983, and IVE Report #1, instead used a value of 18,000kJ/kg. Thus, the PHUs cited here are uniformly slightly higher than those previously reported.)

The second method of calculation did include the charcoal remaining at the end of the test. The formula used for each pot was:

$$PHU_c = \frac{4.186MT + 2,260E}{17,150W - 29,000C} \times 100\%$$

where C is the mass of the charcoal remaining at the end of the test and 29,000 kJ/kg is its calorific value.

The total PHU in each case was then the sum of the individual pot PHUs.

Ten tests were done on each stove. The averages and standard deviations for each are recorded in the following table.

TABLE I
PHUs OF STOVES TESTED

STOVE	PHU POT 1	PHU POT 2	PHU POT 3	PHU TOTAL	(PHU_c)
Three Stone Fire	14.8			14.8±1.5	(17.0)
One-Hole Massive Stove with Chimney:					
Nouna 31	15.3			15.3±0.9	(16.9)
Two Hole Massive Stoves with Chimneys:					
AIDR 2	14.3	5.3		19.6±0.6	(21.6)
CATRU	13.0	5.6		18.6±4.6	(20.4)
Kaya 2	12.3	5.6		17.9±1.6	(19.8)
Nouna 2	13.9	6.3		20.2±1.3	(22.1)
Nouna 32	14.3	4.5		18.8±0.7	(21.4)
Titao	9.4	3.5		13.0±0.7	(15.4)
Three-Hole Massive Stoves with Chimneys:					
AIDR 3	13.0	4.0	2.2	19.2±0.8	(21.8)
Kaya 3	8.9	5.1	3.5	17.5±1.1	(20.1)
Two-Hole Massive Chimneyless Stove:					
Banfora	15.6	6.5		22.1±1.1	(26.7)
One-Hole Lightweight Chimneyless Stoves:					
Metallic Cylinder	26.9			26.9±1.0	(29.1)
Ceramic Stove	30.8			30.8±2.3	(31.9)

Several conclusions can be drawn from these results:

1. The thermal performance of the three stone fire was much higher than that normally quoted in stove literature, and thus significantly increases the demands on the performance of "improved" stoves.

2. The chimneyless stoves tested perform better than those tested with chimneys. The reasons for this are that chimneyless stoves have (A) more surface area of the pot exposed to the hot gases and, (B) a shape that also forces the hot gases close to the surface of the pot to improve convective heat transfer. (However, it should be noted that the CATRU stove, in spite of the modified pots and banco interior contoured to the shape of the pots, satisfied the conditions needed for convective heat transfer--that is, a large exposed pot surface area and a narrow gap through which the hot gases must pass--but did not perform particularly well due in part to the difficulty of establishing a draft through it.)

   Other factors improving the performance of the lightweight stoves in particular are (C) grates to improve combustion and (D) low mass to reduce the amount of energy needed to heat the stove body itself.

3. The efficiency of the second pot was much less than that of the first in all the multi-pot stoves tested. This may be a particular problem in stoves in which the two pots are of such different size they cannot be interchanged. In this case, the second pot must reach boiling temperatures if it is to be useful; however, to reach the boiling point, very high firepowers are necessary which can in turn eliminate potential wood savings (as well as overcook food in the first pot).

4. The efficiency of the third pot in the AIDR 3 stove was too small to be of much use. In addition, the efficiency of the second pot in this stove appeared to be lowered by the presence of the third.

5. The performance of the first pot is slightly higher in the Banfora than in the other multi-pot stoves. It is suspected that this is due to the smaller draft in this stove, and thus a combination of less cooling of the first pot by incoming fresh air; possibly longer retention times of the hot gases against the pot; and perhaps the larger amount of charcoal produced in this stove providing greater radiant transfer.

6. The efficiency of the first pot in the stoves with chimneys is equal to or less than that of the open fire.

Controlled Cooking Tests

A series of tests was done to observe the performance of these stoves in actual cooking. All ingredients for both "tô" and gumbo sauce were weighed out to 1 gram precision and with few exceptions, the same quantities were used in each test. A preliminary series of tests was done by one "animatrice" to survey all the stoves. From these, five stoves were chosen from the group for additional tests. Four different animatrices prepared the meals, each cooking one time on each stove. Table II shows the performance of each stove at least in terms of the kilograms of dry wood needed to prepare each kilogram of cooked food, or specific consumption.

TABLE II
SPECIFIC CONSUMPTION OF STOVES TESTED

	ANIMATRICE				
STOVE	**1**	**2**	**3**	**4**	**AVERAGE/ECONOMY**
Three Stone	0.265	0.293	0.270	0.242	0.268/+0%
Nouna 2	0.246	0.244	0.243	0.216 0.270	0.242/+9%
Banfora	0.258	0.239	0.199 0.191	0.259 0.237	0.231/+14%
AIDR 3	0.314	0.317	0.261	0.324	0.304/-13%
Metallic	0.164	0.164	0.155	-----	0.161/+40%

The metal stove used much less wood than the others. The two- and three-pot stoves did not perform as well as expected from the laboratory tests because the second pot efficiency was too low to provide effective cooking power. Thus, to cook the food the pots were switched as needed and actual cooking was done mostly on the first pothole; the second pothole was used to preheat the water before cooking on the first hole or to keep the food warm after it was cooked on the first hole. Alternatively, the food could have been cooked on the second hole if a very large fire was used, but that would have both drastically overcooked the food on the first pothole as well as consumed even more wood.

Thus, in the limit that the second pothole efficiency goes to zero, the performance is clearly determined only by the first pothole. In the other extreme where the second pothole efficiency increases to that of the first or even higher, the performance of the stove in cooking a meal will be determined by a combination of the efficiency of the two depending on their relative performance and the meal being cooked. It should therefore be noted that, in general, cooking several pots simultaneously from a single fire greatly reduces the efficiency with which the fire can be controlled as well as the flexibility of the stove to handle different cooking tasks.

It is interesting to compare various combinations of laboratory efficiencies to the above wood consumption per kilo of cooked food. Since the specific consumption should decrease as the thermal efficiency increases we will compare the PHU to the value of 1/(specific consumption). Table III gives the average specific consumption (from Table II) and its inverse and the correlation coefficient for these (X) values versus (Y) values of: (1) the total PHU of the stove; (2) the PHU of the first pot only; and, (3) the PHU of the first pot plus half that of the second.

TABLE III
AVERAGE SPECIFIC CONSUMPTIONS AND CORRELATION COEFFICIENTS

STOVE	SC	1/SC	(1)	(2)	(3)
Three Stone	0.268	3.73	14.8	14.8	14.8
Nouna 2	0.242	4.13	20.2	13.9	17.1
Banfora	0.231	4.33	22.1	15.6	18.9
AIDR 3	0.304	3.29	19.2	13.0	15.0
Metal	0.161	6.21	26.9	26.9	26.9
Correlation Coefficient 1/SC vs (1), (2), (3)			0.854	0.967	0.986

We can do the same linear regressions including all the stoves in the controlled cooking. (Note that the following were tested only once each.)

TABLE III.A

STOVE	SC	1/SC	(1)	(2)	(3)
AIDR 2	0.323	3.10	19.6	14.3	17.0
CATRU	0.372	2.69	18.6	13.0	15.0
Kaya 2	0.269	3.72	17.9	12.3	15.1
Kaya 3	0.511	1.96	17.5	8.9	11.5
Nouna 32	0.222	4.50	18.8	14.3	16.6
Titao	0.421	2.38	13.0	9.4	11.2
correlation coefficient including all the above eleven stoves			0.763	0.903	0.905
slope			0.248	0.225	0.254
PHU (y) = 100		1/SC =	23.7	23.0	24.9

Certainly, additional linear regressions could be done with different combinations of the laboratory efficiencies. However, it is clear that for the tests presented here, there is a good correlation (a perfect correlation would be +1.0) between a modified laboratory PHU, such as case 2 above, and the performance of the stove in actually preparing a meal as measured by the inverse of its specific consumption. It must be emphasized, for example, that the Kaya 3 and Titao stoves which had the lowest first hole efficiencies also had by far the highest specific consumption in the kitchen tests. Again, the reason for this is that the second and third potholes do not provide effective cooking power and thus, primary reliance is on the first hole. Therefore, even stoves with an overall PHU higher than that of the open fire can still consume more wood than the open fire in cooking (as seen in the case of the AIDR 3 and Kaya 3 stoves above).

It is also interesting to note in the linear regressions above that "perfect" stoves, that is those with a PHU of 100, or equivalently having all the energy released by the wood absorbed by the contents of the pot (ignoring the pot mass), give a value of about 24 for the inverse of the specific consumption, or 0.0419 kg dry eucalyptus wood burned per kg of food produced. The amount of energy needed to heat 1 kg of water from 20°C to boiling is equivalent to about 0.0183 kg of wood or an inverse specific consumption of 55. As the energy required for the chemical conversion of food during cooking is negligible (Geller), we can assume that the difference above is due to evaporation. However, this evaporation is, at least in part, a necessary factor in the overall cooking process, particularly for such foods as tô. It cannot be totally eliminated nor should it be considered in its entirety a loss.

It is hoped that when a sufficient data base is available, similar regressions can be done between field tests and lab tests, and between field tests and controlled cooking tests in order to improve lab and controlled cooking test methodology and to allow better prediction of field performance.

Heat Recuperation Tests

After the cooking test was completed, pots of cold water with lids were placed on the stove to warm and to observe how much of the heat held in the stove walls could be recuperated. For these tests, the remaining charcoal was swept from the stove, and the door and chimney blocked. The results indicated that typically only 0.6 to 1.35% of the energy released by the fire could be recuperated in this manner. This is in notable contradiction to the frequent statement of the potential of massive stoves to recuperate heat. It is likely that heating in this manner is actually done on hot coals left in the stove.

Thus, it is more efficient to use a high efficiency stove to cook with and to then light a fire in it a second time to heat water with than to use a low efficiency massive stove for cooking and attempt to recuperate some of the heat stored in the stove body for heating water later.

Family Compound Tests

Because the performance of the three stone fire was so high in the laboratory, tests were done to see if these results were representative of three stone fires in family compounds. High power boiling water tests using fixed 1.000 kilogram charges of the Eucalyptus wood from the laboratory were done on the three stone fires in thirty different family compounds. In each case, the three stone fireplace was swept clear of ashes and debris and the 1 kg charge of wood was completely burned. The test was stopped when the wood itself had finished burning. The tests were done by the same animatrices who ran the boiling water and cooking tests in the laboratory. All the pots used for the tests were aluminum and were provided by the families themselves. Pot and water weights were measured before and after the test using a balance with 10 gm precision. Charcoal was not recuperated at the end of the test. The results are listed in Table IV.

TABLE IV
FAMILY COMPOUND THREE STONE FIRE EFFICIENCIES

EFFICIENCY	NO. OF FAMILIES
8-10%	3
10-12%	4
12-14%	6
14-16%	7
16-18%	6
18-20%	3
20-22%	1
Average = 14.5 + 3.1%	

These results do not include recuperable charcoal and thus have to be compared to the open fire performance not including charcoal of 14.8% in the laboratory. There was also a strongly observed correlation between the efficiency of the stove and where it was located. For those three stone stoves in the family courtyard, the average efficiency was 12.8%. For those three stone stoves located inside a kitchen the average efficiency was 16.7%. There were no strong observed correlations between pot size nor ground-to-pot distance, perhaps due to the small size of the sample.

Conclusions

The testing program has shown that massive stoves with chimneys which use spherical pots can (but sometimes do not) perform better than an open fire, but they do not show the high thermal efficiencies and thus large wood economies desired to have a truly significant impact on the Sahelian wood fuel problem.

On the other hand, the lightweight chimneyless stoves show the potential of good wood economies, portability, low cost, ease of construction, and ease of quality control during construction due to it being done in centralized facilities. Their drawbacks, however, include not evacuating the smoke from the kitchen, and being less stable when making such dishes as tô. Questions also remain concerning the durability of the lightweight stoves of fired clay in day to day use.

Research is now continuing in two directions. First, lightweight chimneyless stoves are being optimized in the laboratory to further improve their thermal performance and tested in the field to determine how serious the potential drawbacks in terms of smoke, stability, and for fired clay stoves, lifetime really are. Second, an effort is being made to modify the form of the pots (making cylindrical pots) so that good wood economies can be achieved simultaneously with the use of a chimney.

Results will be forthcoming.

II. DESIGN OF THE STOVES TESTED

Designs for and the dimensions of each stove tested are shown on the following pages. Below is a brief description of each individual stove. All the stoves were built by the same masons that build such stoves daily in the field for their respective organizations.

The same size pots--#3--were used on all the stoves except for the third pot in the three-hole stoves--that is the third pot in the AIDR 3, the Kaya 3, stoves and Nouna 31 which used #4 pots. The nominal dimensions of these pots are summarized in Table V below.

TABLE V
SUMMARY OF POT DIMENSIONS

POT	#3	#4
Top diameter	24.5	27.5
Maximum diameter	27.0	30.5
Total height	19.0	21.0
Height from bottom to maximum diameter	10.0	10.0
Volume (liters)	7.8	11.5

The values of the pot weights themselves can be seen in the data in section IV.

The **three stone fire** was made of three rocks placed on a concrete slab with a ground to pot distance of 10 cm.

The **fired clay** stove is described in detail in the October and February reports as stove "E1" and which will not be repeated here.

The **metal** stove was based on the dimensions of stove K in the February report. Detailed design and production details are given by the Sepps. In brief, the stove was 92 cm in circumference (around a pot 87 cm in circumference) with a grate made of strips of scrap metal welded together and a grate to pot distance of about 10 cm. The metal used throughout was 1 mm thick sheet and was formed by hammering and then welding into place.

The **AIDR** stoves were formed with walls of standard preformed banco bricks, an interior including a baffle of banco, a trapezoidal metal cased doorway, a reinforced concrete top plate, and a chimney of cement bricks at the bottom and fired clay tubing at the top. For the

AIDR 2 stove, the ground to pot A distance was 11 cm, and the minimum baffle to pot B distance was 7 cm.

The **Banfora** stove was made of banco bricks and a banco interior subsequently carved out and a rainproofing coating of a cement, sand, and clay mixture. The distance from the ground to pot A was 13 cm and from the baffle to pot B varying with a minimum of roughly 2 cm.

The **CATRU** stove was made with preformed reinforced concrete walls, a cast aluminum top plate, and an interior of banco that crudely followed the pot shape several centimeters away. The door was metal clad and the chimney was made of concrete blocks with a rain hat on top. The ground to pot A distance was roughly 13 cm, and typical distances to the second pot were on the order of 2 to 3 cms.

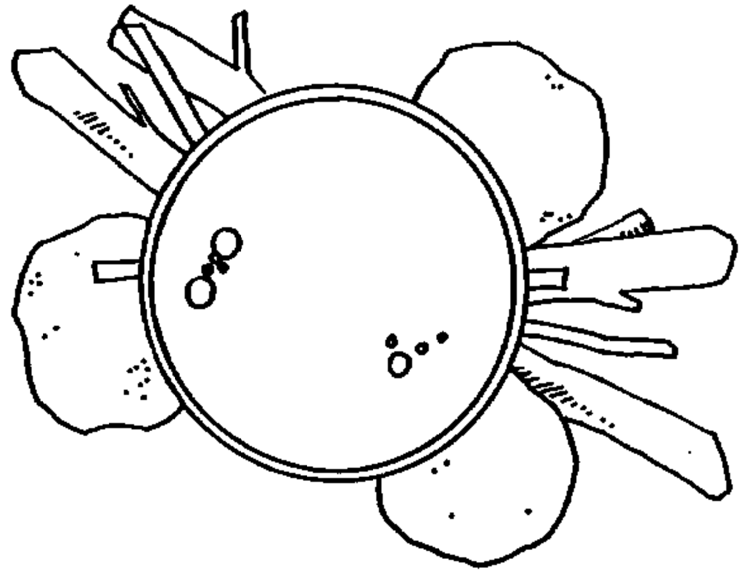
The **Kaya** 2 hole stove was made with banco brick walls and a banco interior with a rainproofing coating of a mixture of cement, sand, and clay. No metal reinforcing was used anywhere. The chimney was made of concrete blocks. The ground to pot A distance was 12 cm and the minimum baffle to pot B distance was 2 cm.

The **Kaya** 3 hole stove was made with banco brick walls, a banco interior and a reinforced concrete top plate. The chimney was made of concrete blocks. The ground to pot distances for pots A and B was 14 cm; the baffle to pot C minimum was 2 cm.

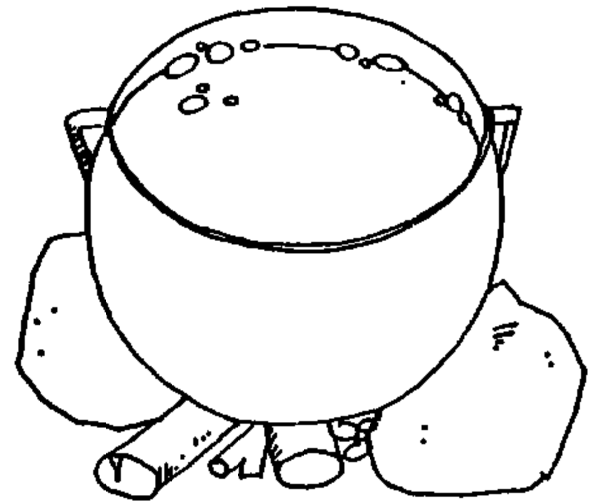
The **Nouna** stoves were all made of concrete block walls, interiors of mortar and broken ceramic bits, and reinforced concrete top plates. The chimneys were made of concrete blocks below and sheet metal tubing above. The ground to pot A distance was 15 cm for the Nouna 31, and 12 cm for the Nouna 32 and Nouna 2 stoves. The minimum baffle to pot B distance was 5 cm in the Nouna 2 and 3.5 cm in the Nouna 32. It should be noted that because the same chimney was used by the Nouna 31 and the Nouna 32, there could be communication between the two and that the effective chimney height in terms of providing a draft was very small.

The **Titao** stove was made with banco walls, a banco interior, and a banco chimney. Pot seats were made from donuts (triangular in cross-section) of fired clay. The pot seats had a bottom inner diameter of 23 cm, a peak inner diameter of 33 cm, and an exterior bottom diameter of 45 cm. The distance from the bottom to the peak was 9 cm. The first pot sat 20 cm off the ground; the second pot sat a minimum of 8 cm above its baffle. (These large gaps and the pot seats wich partially covered the pot bottom accounted for much of its poor performance.) In general, the shape of the stove was fairly irregular.

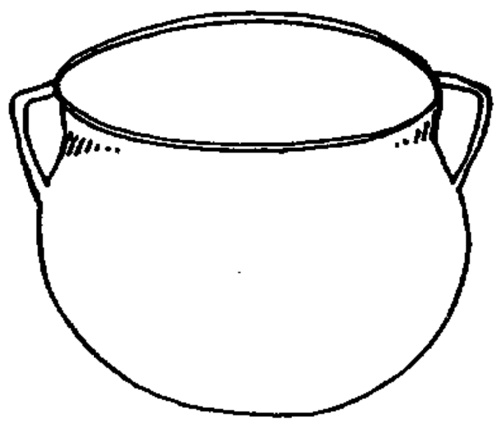
THREE STONE FIRE - TOP



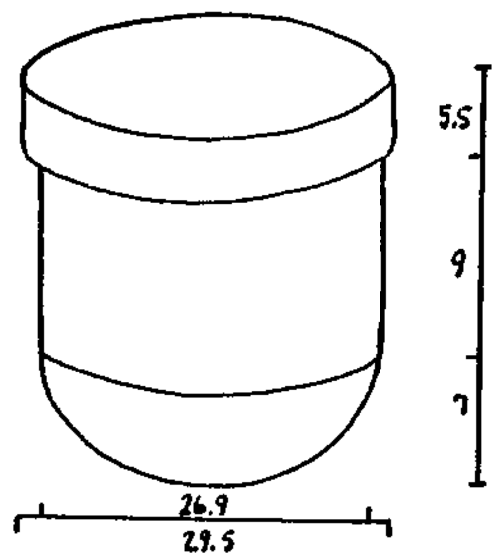
THREE STONE FIRE - PERSPECTIVE

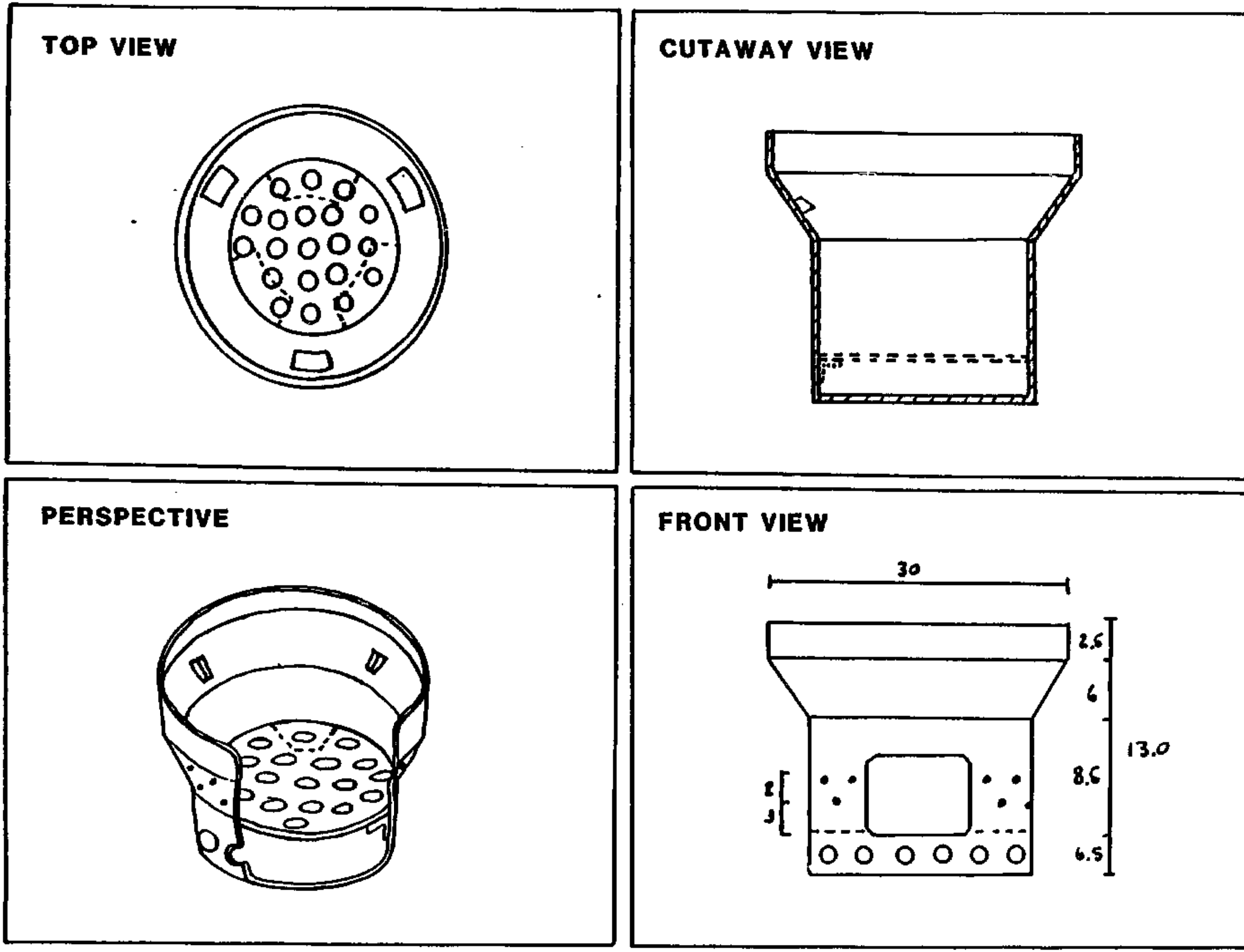


SPHERICAL POT

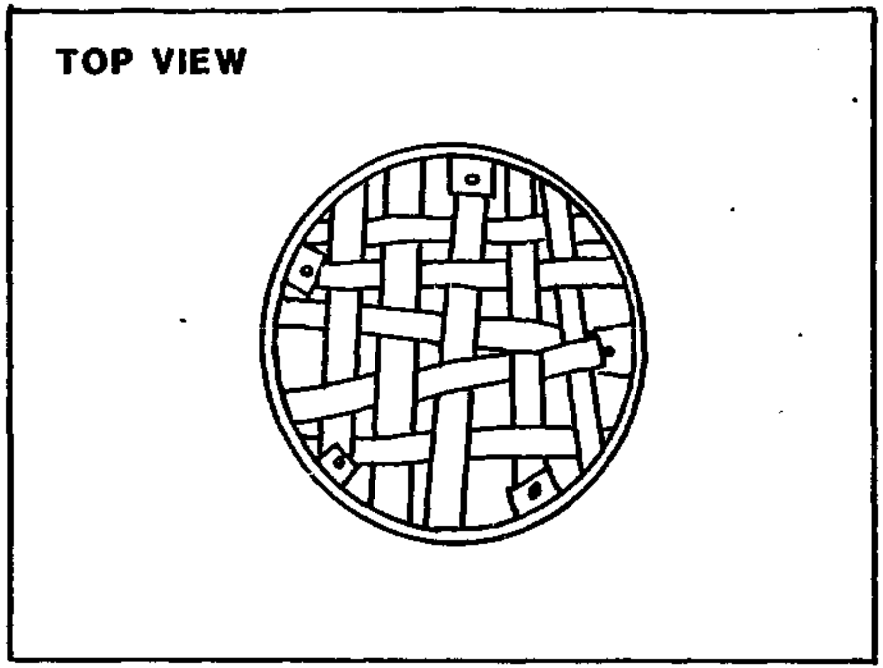


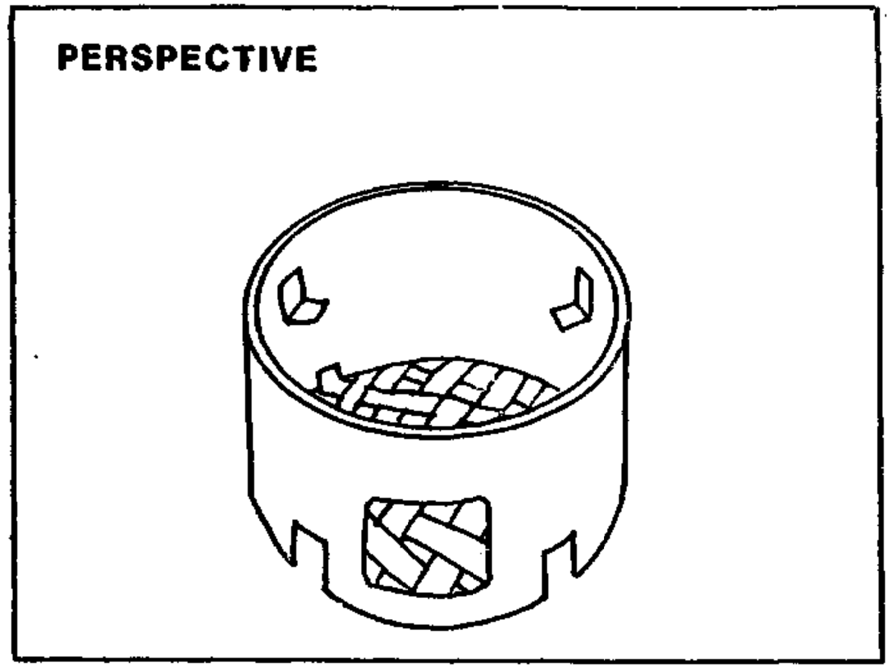
CATRU POT

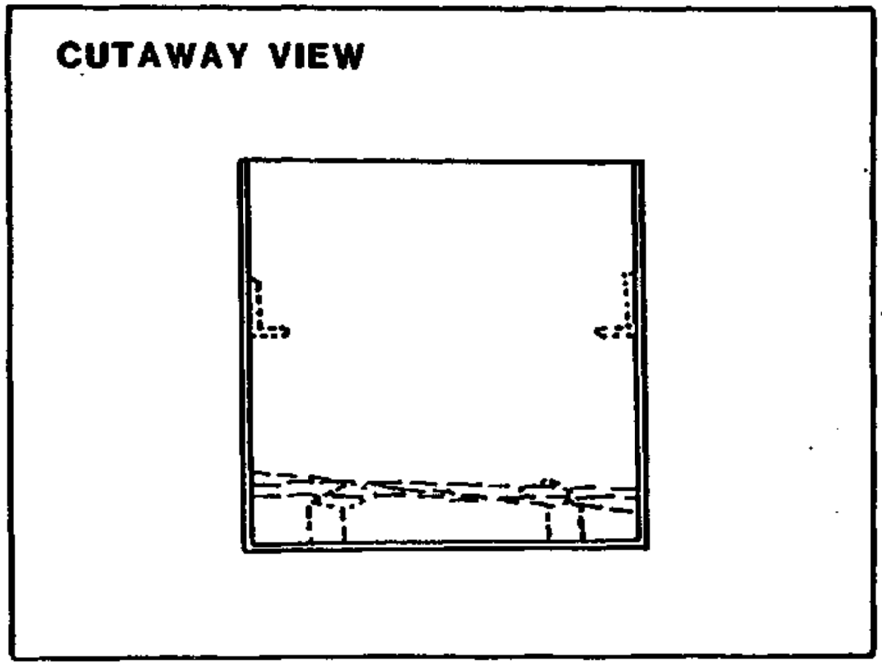


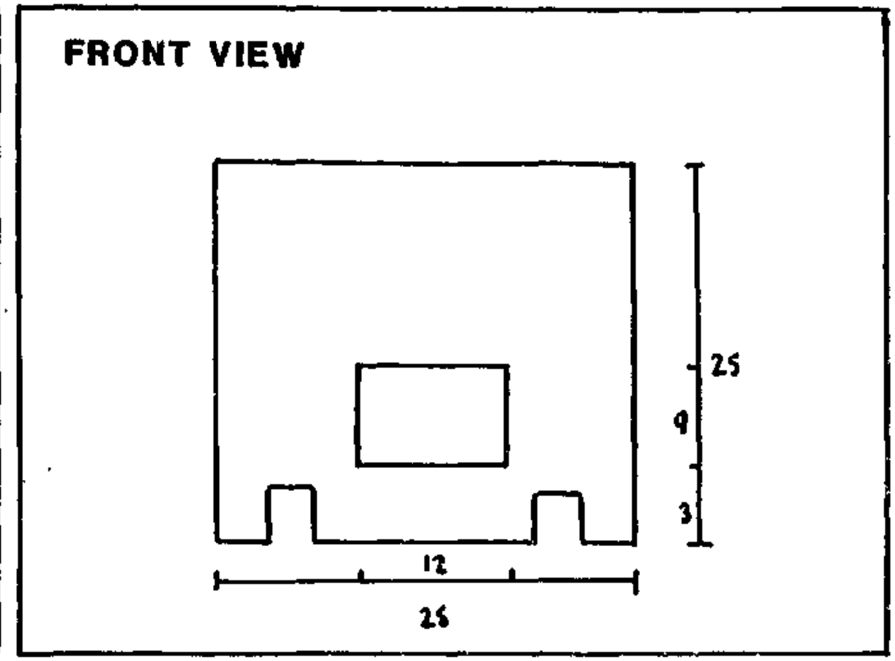


FIRED CLAY STOVE

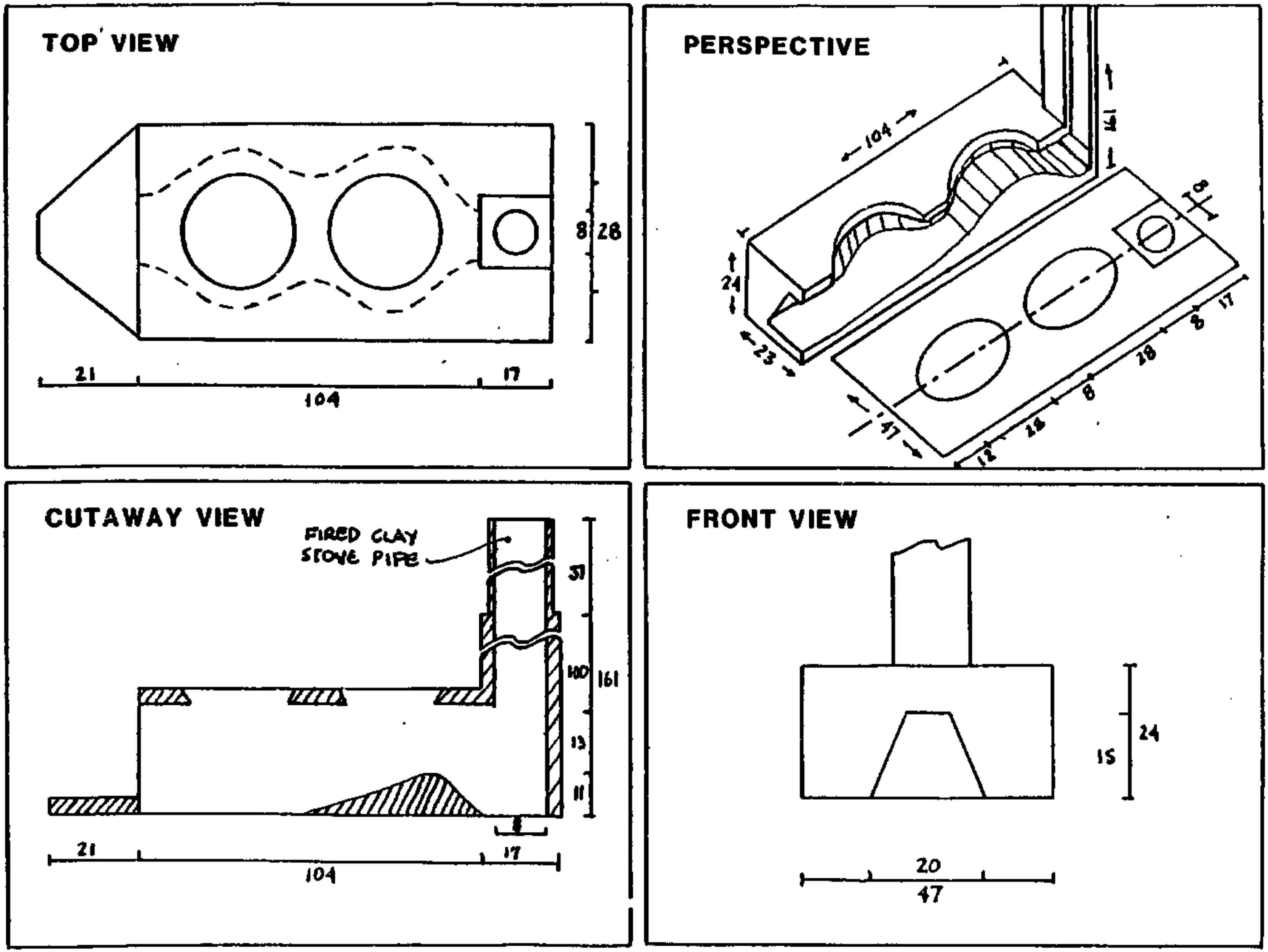








METAL STOVE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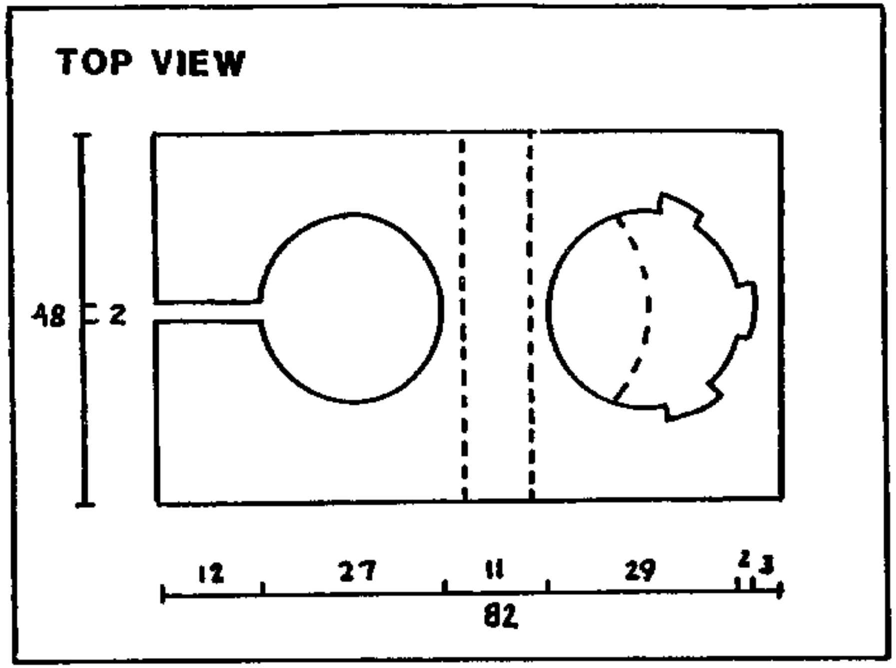
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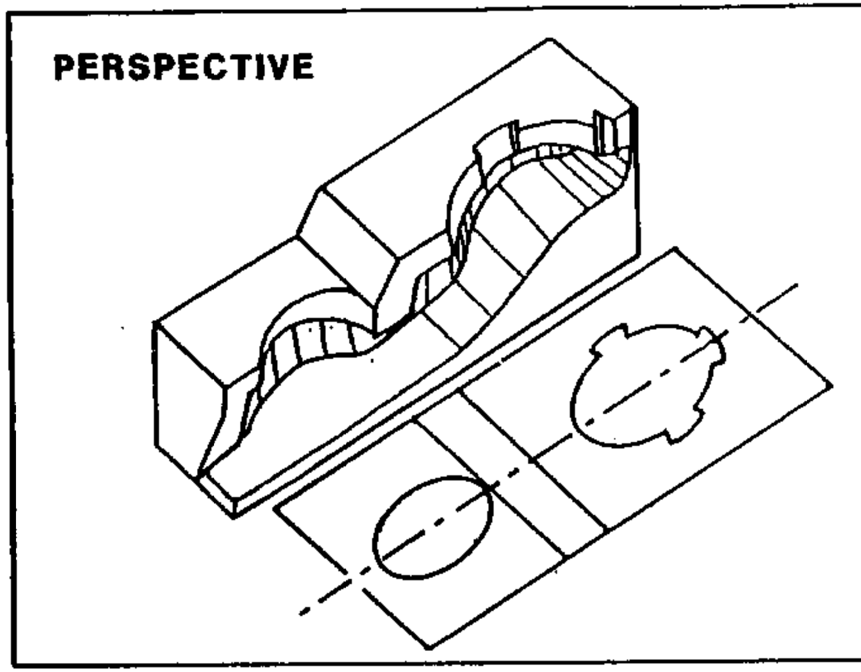
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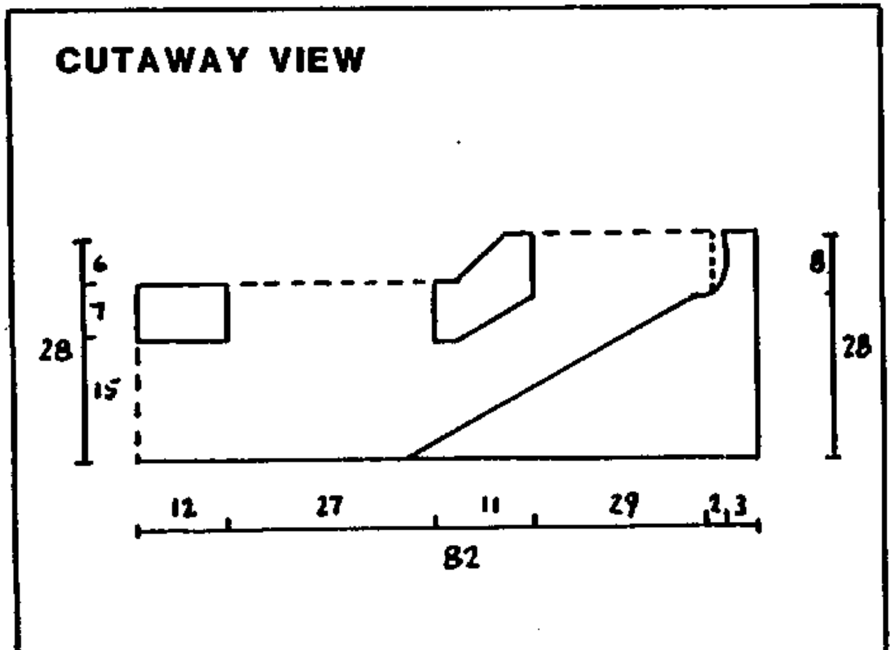
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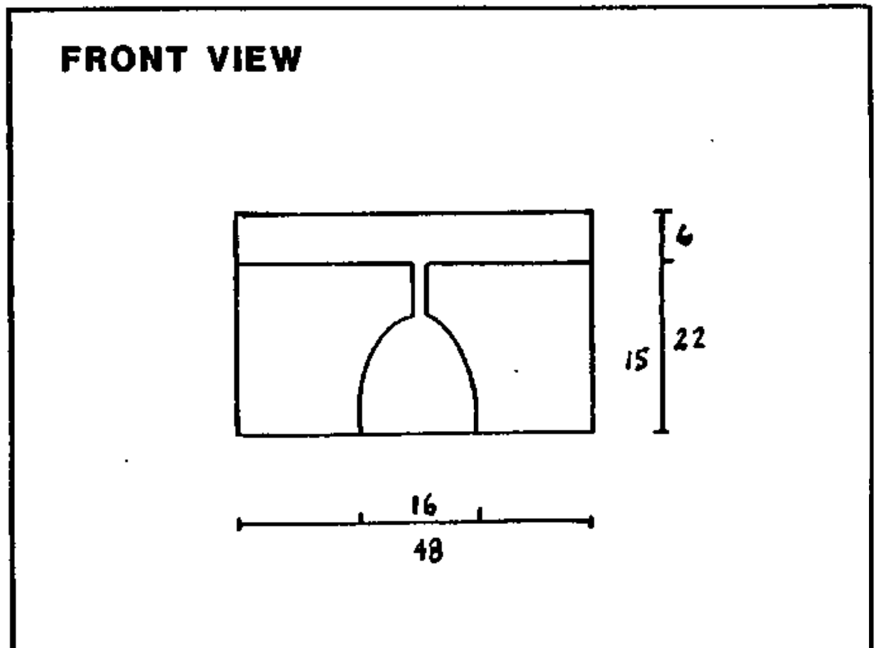
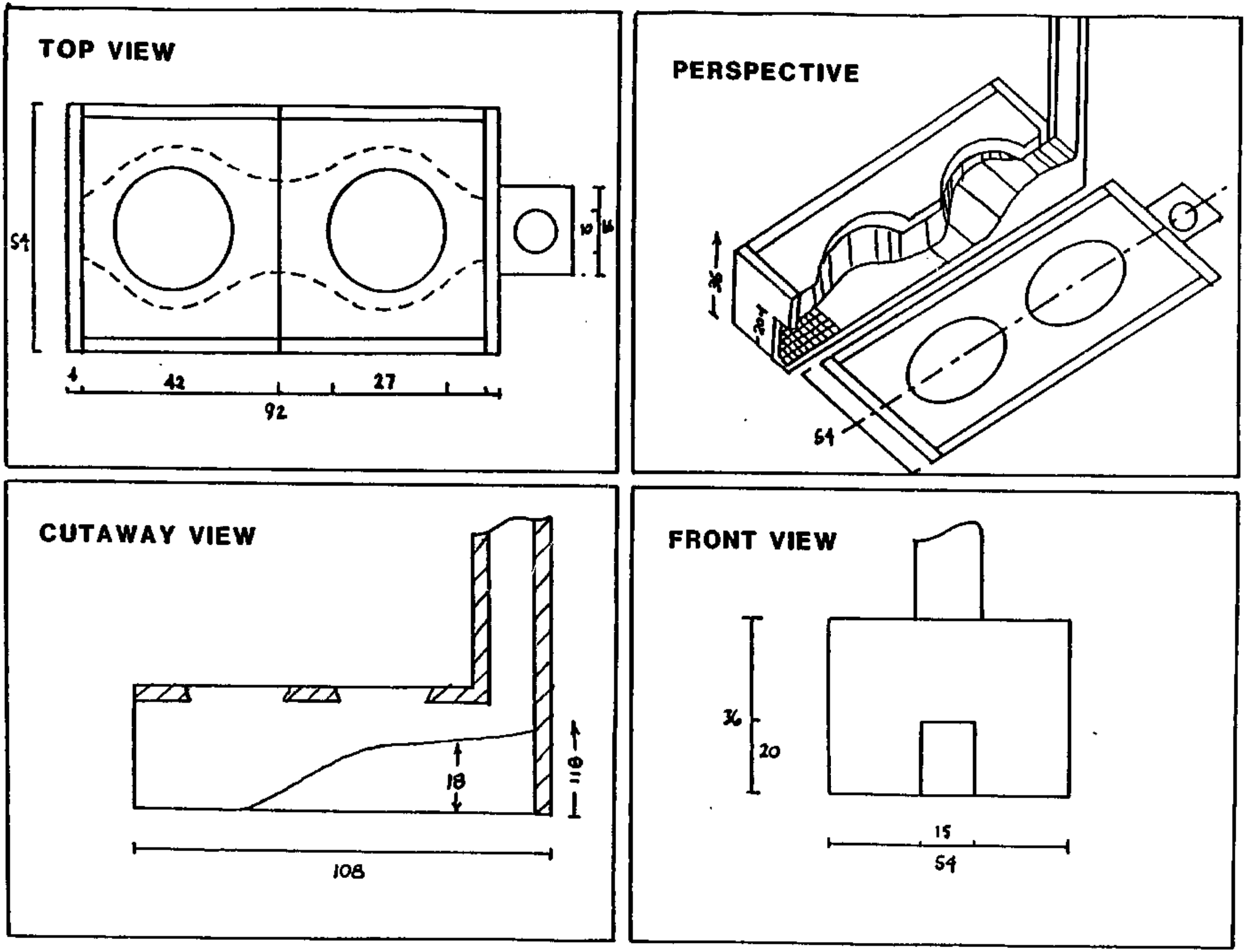
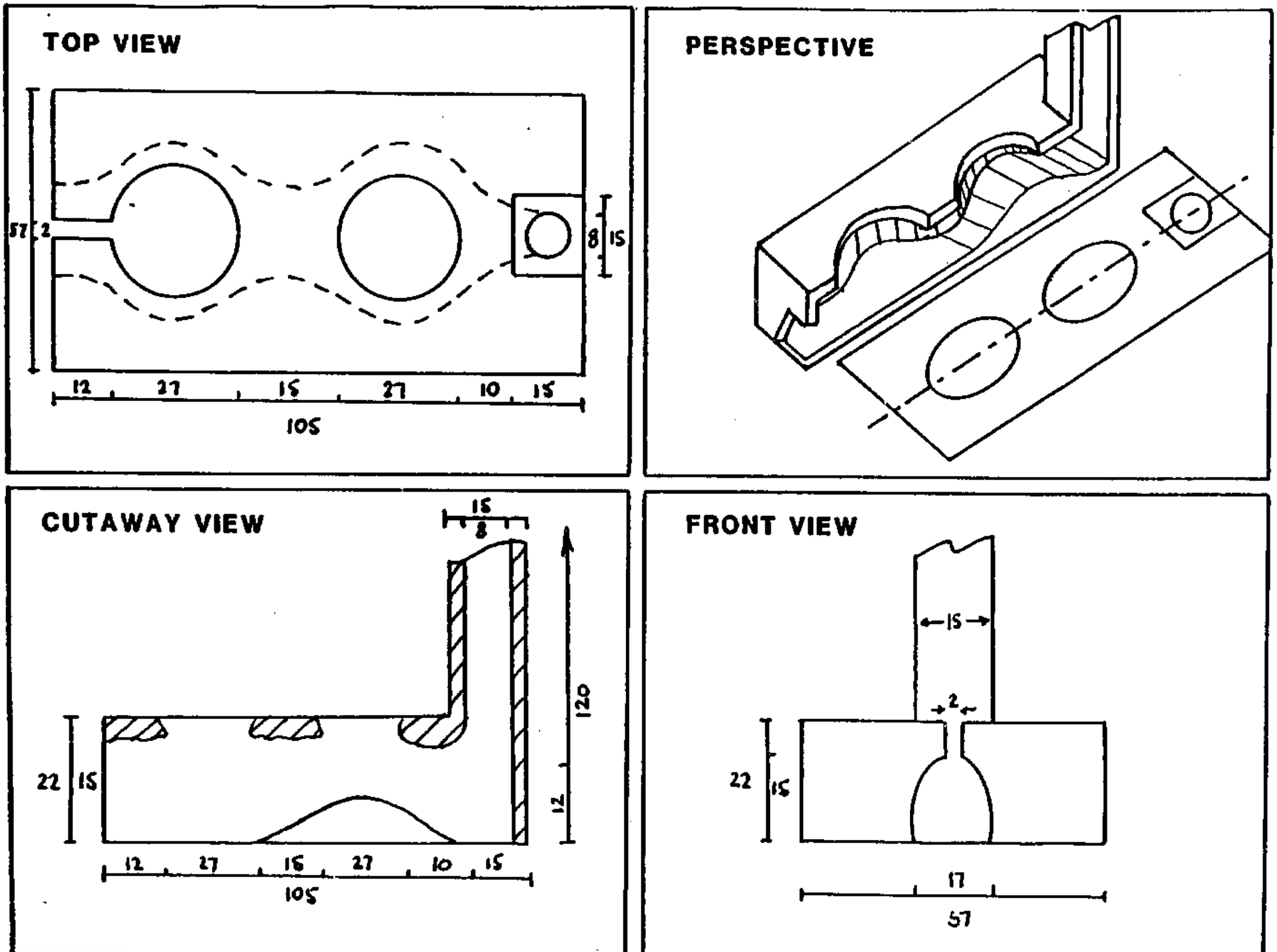

FRONT VIEW
6
15
22
16
48

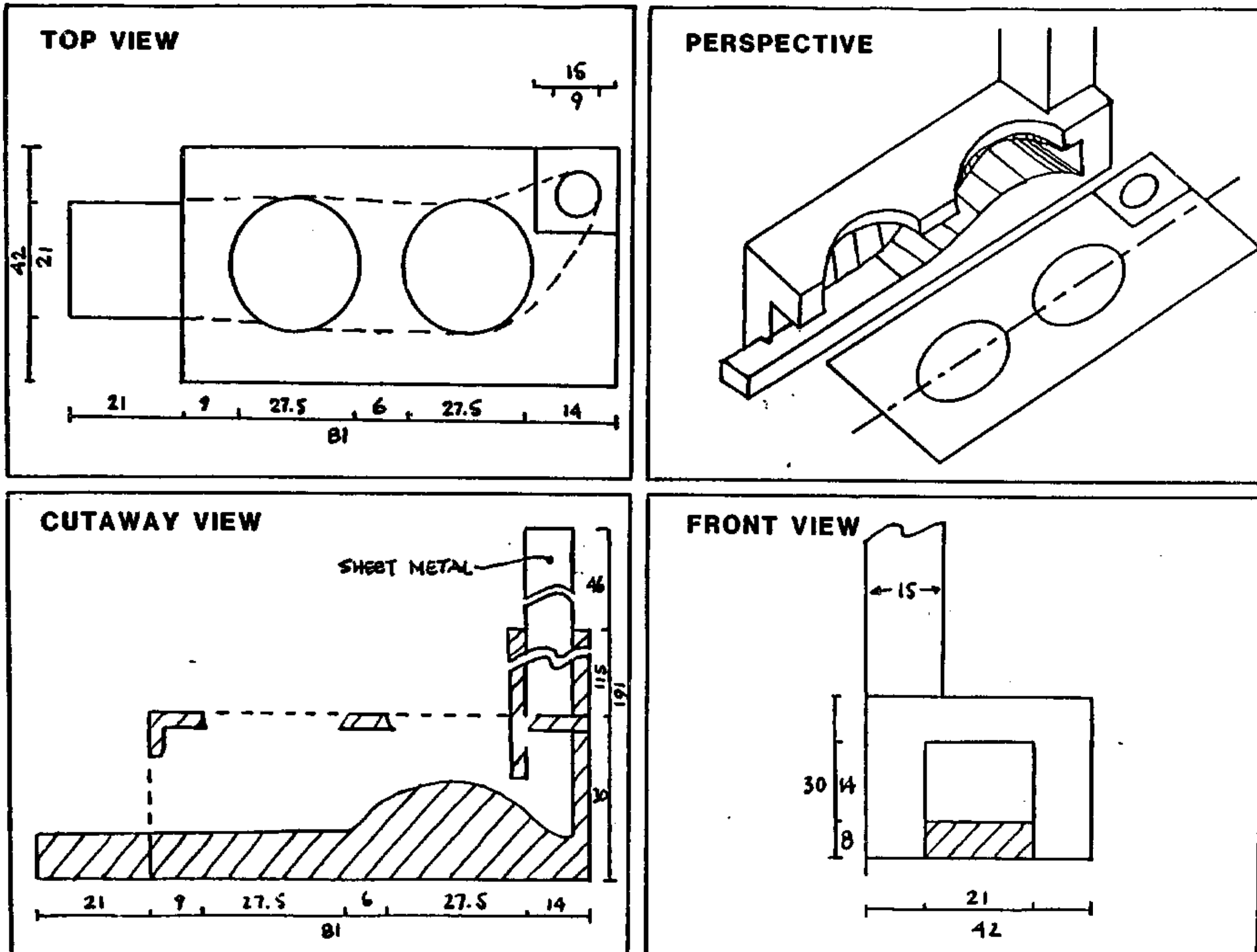
BANFORA


TOP VIEW
54
4
42
27
92
10
16
PERSPECTIVE
36
20
54
CUTAWAY VIEW
18
108
118
FRONT VIEW
36
20
15
54

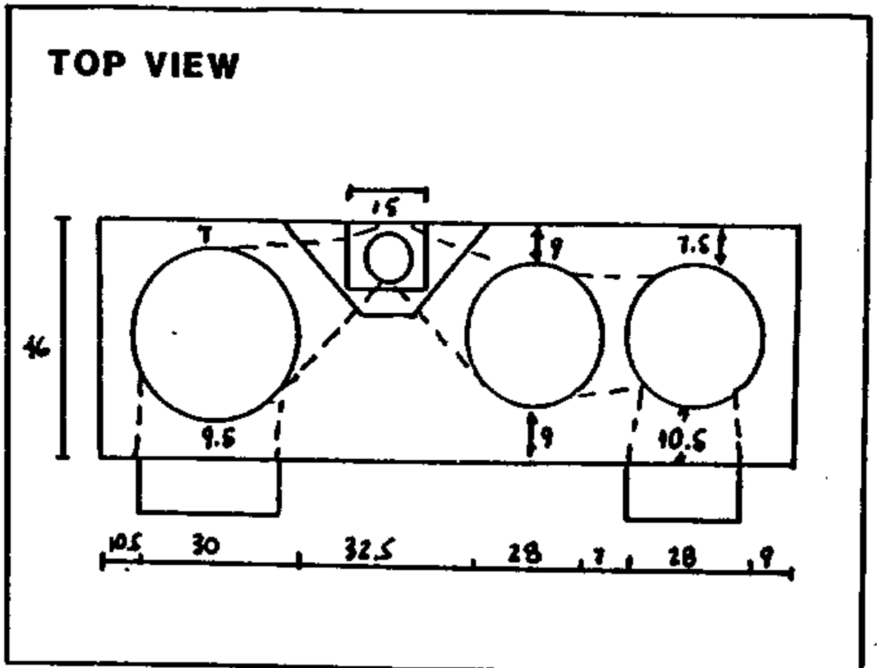
CATRU

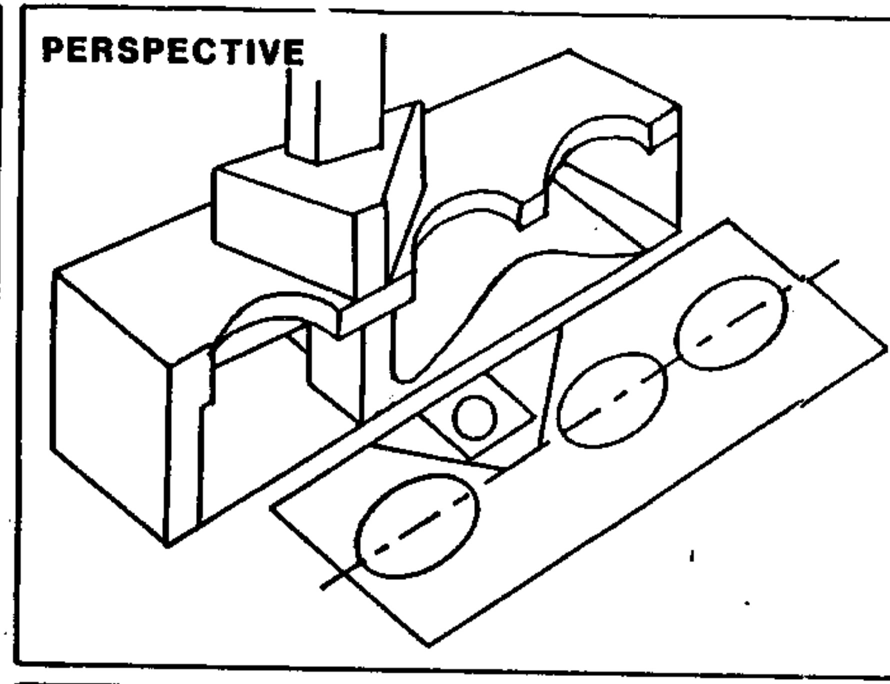

TOP VIEW
57
2
8
15
12
27
15
27
10
15
105
PERSPECTIVE
CUTAWAY VIEW
15
8
120
12
22
15
12
27
15
27
10
15
105
FRONT VIEW
15
2
22
15
17
57

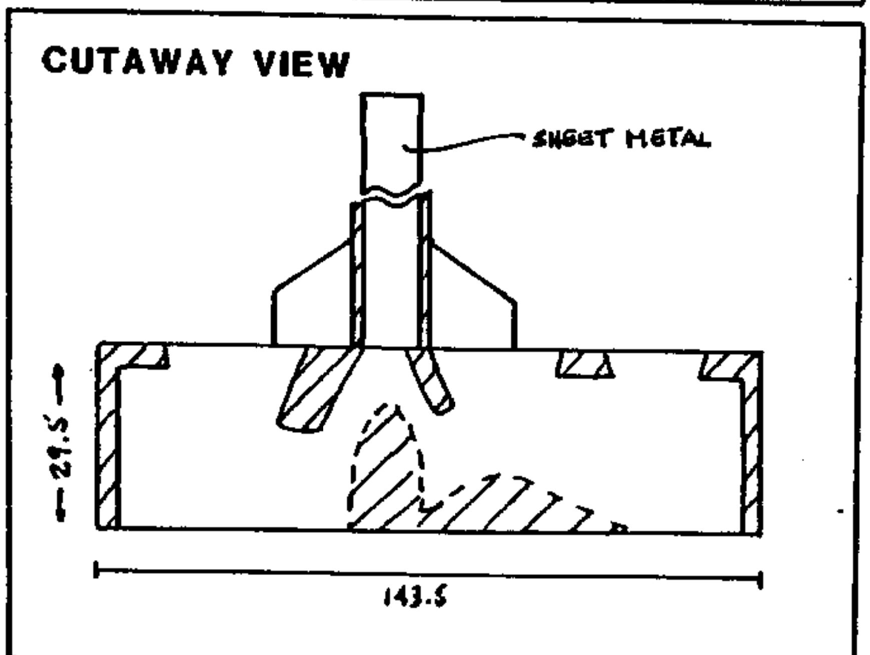
KAYA 2

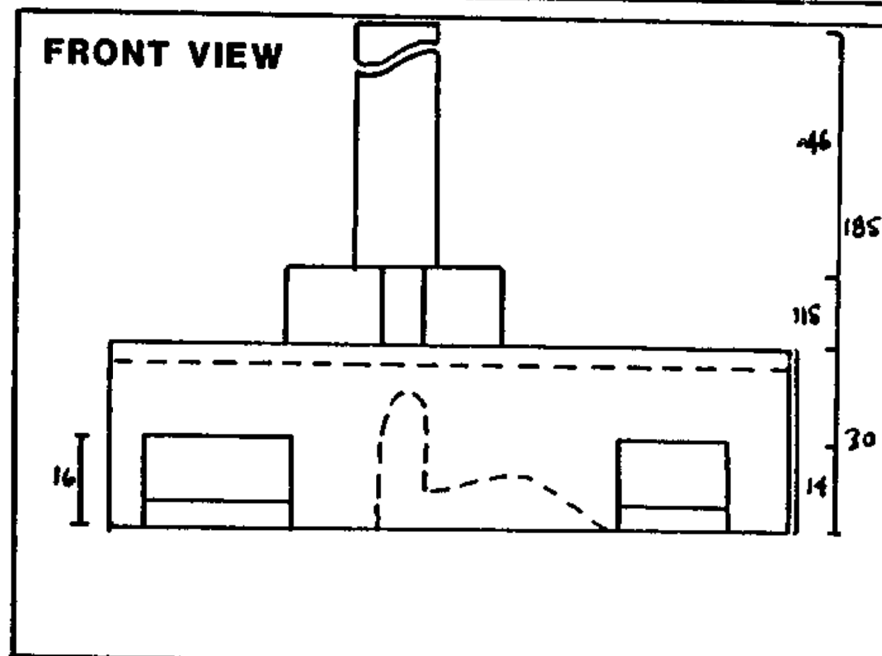

TOP VIEW
16
9
42
21
21
9
27.5
6
27.5
14
81
PERSPECTIVE
CUTAWAY VIEW
SHEET METAL
46
115
161
30
21
9
27.5
6
27.5
14
81
FRONT VIEW
15
30
14
8
21
42

NOUNA 2

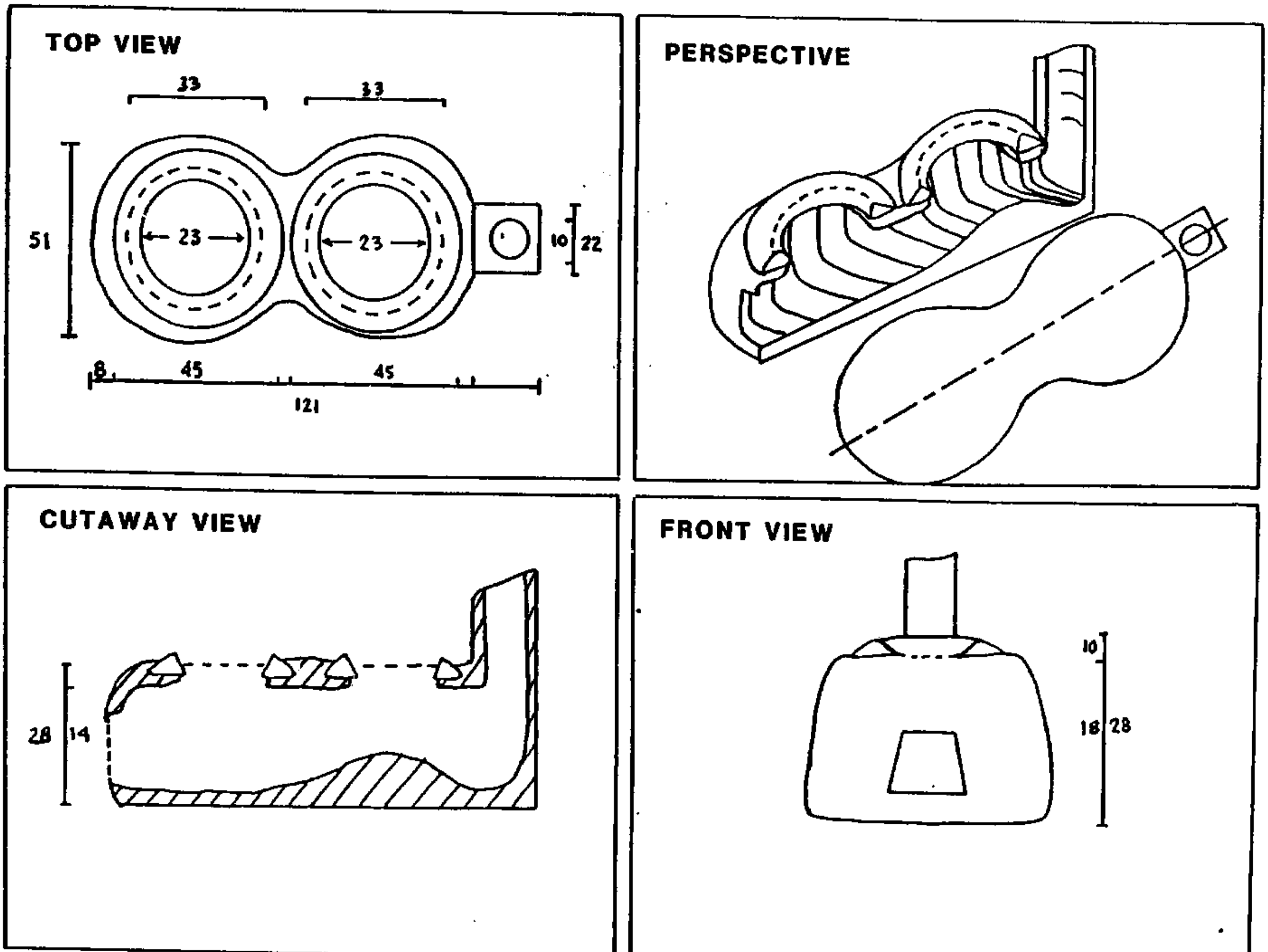

TOP VIEW
15
T
9
7.5
46
9.5
9
10.5
10.5
30
32.5
28
7
28
9


PERSPECTIVE

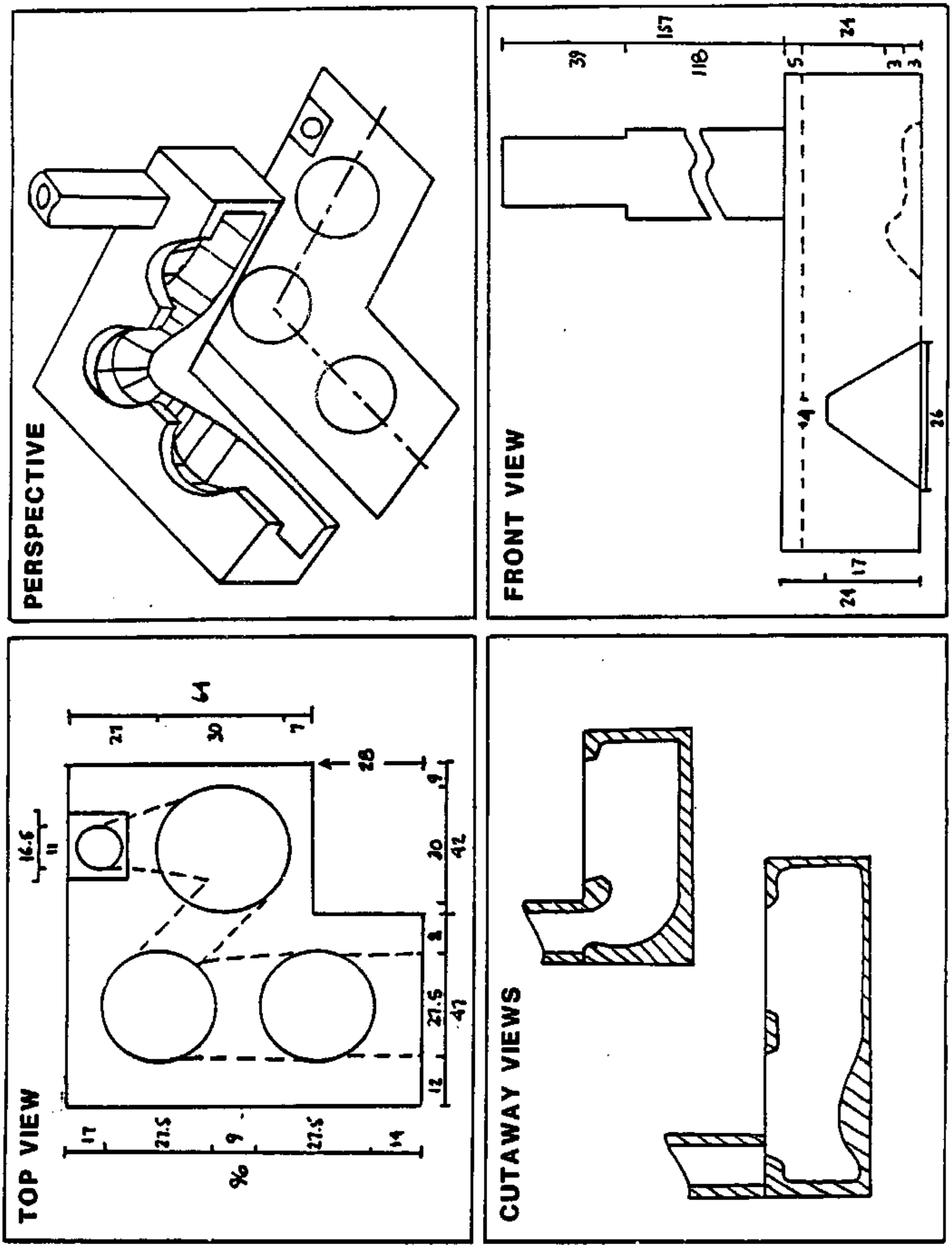

CUTAWAY VIEW
SHEET METAL
29.5
143.5


FRONT VIEW
46
185
115
30
14
16

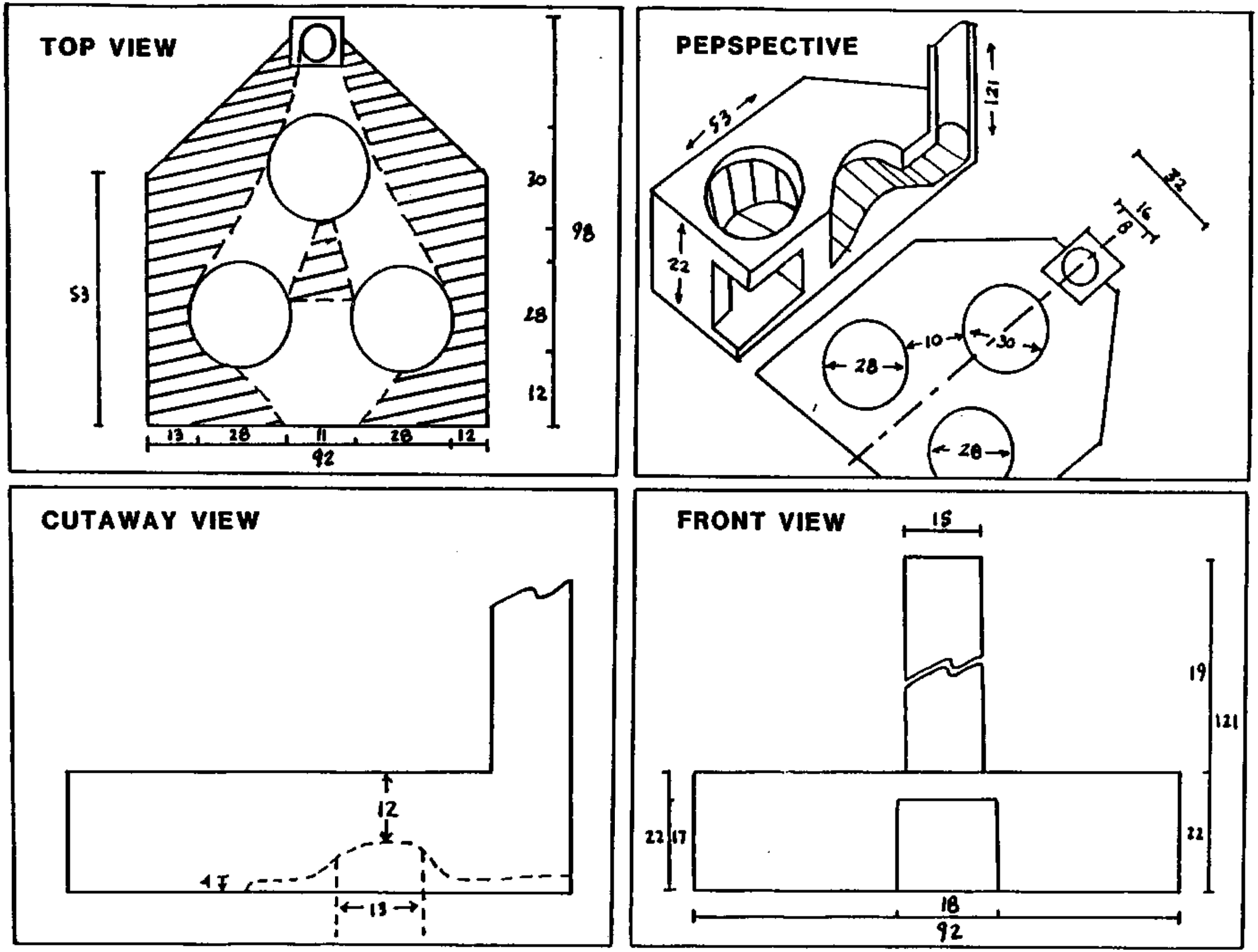
NOUNA 31/32


TOP VIEW
33
33
51
23
23
10
22
8
45
45
121
PERSPECTIVE
CUTAWAY VIEW
28
14
FRONT VIEW
10
18
28

TITAO


PERSPECTIVE
FRONT VIEW
157
39
118
5
24
3
3
26
14
24
17
TOP VIEW
64
21
30
7
16.6
11
28
9
30
42
8
27.5
41
12
96
17
27.5
9
27.5
14
CUTAWAY VIEWS

AIDR 3


TOP VIEW
53
13
28
11
28
12
92
30
98
28
12
PEPSPECTIVE
53
121
22
32
16
8
28
10
30
28
CUTAWAY VIEW
12
4
13
FRONT VIEW
15
19
121
22
22
17
18
92

KAYA 3

III. LABORATORY TEST METHODOLOGY

The stoves were all built by the same masons who construct stoves in the field for their respective organizations. All stoves were built or placed side by side in the same hangar against one wall. The protection against the wind was reasonably good but certainly not complete. The effect of the wind can be seen by comparing the laboratory performance of the three stone fire with that found in family compound tests inside the kitchen (16.7%) or outside (12.8%).

The same species of wood, Eucalyptus camaldulensis, was used for all tests. Tests done at TNO in the Netherlands found the gross calorific value for this species to be 19,750 kJ/kg and the net calorific value to be 18,325 kJ/kg. Bomb calorimetric tests done at the Institut Supérieur de l'Université de Ouagadougou established a value of 18,105 kJ/kg. The wood moisture content was measured once during the series of tests. Placing the wood in a 105°C stove found the following:

TABLE VI
WOOD MOISTURE CONTENT TEST

DATE	WEIGHT	REMARKS
Jan. 5	824.3 gms	Start
Jan. 6	787.3	--
Jan. 7	779.1	--
Jan. 10	777.1	Finish

Using the TNO data and the above value of the moisture content, 6%, we find a calorific value per kilogram of wet wood of about 17,150 kJ/kg.

Four different testers tested the stoves, each person testing each of the stoves to reduce the bias among themselves.

All stoves were used several times before testing began to thoroughly dry them, and all stoves were tested only once per day to ensure that they were cold at the start of the test.

All weights were measured to 1 gram precision using a Sartorius digital balance with a capacity of 7 kg. All temperatures were measured with mercury in glass thermometers accurate to at least 1°C.

The methodology used generally followed that reported previously in the October and February reports. The test methodology is a high power boiling water test modeled after those used by Tim Wood of VITA, Stephen Joseph of ITDG, the draft procedure developed by the "Working group meeting on a woodstove field test standard, Marseille, 12-14 May 1982" and others. Results are reported in terms of Percent Heat Utilized or PHU. It should be noted that this work was done before the provisional international standards, developed at Arlington, Virginia, in December 1982, became available and has no relation to that methodology or method of calculation.

The testing procedure was as follows:

1. The stove and area around it are swept clean of ashes and other debris. Stoves are felt to make sure they are cool. Massive stoves are only tested once per day. The lightweight stoves could be tested more frequently because of their low thermal mass.

2. Weather conditions, particularly the wind, are noted.

3. Wood is chopped into pieces roughly 2-4 cm by about 20 to 30 cm long, along with a number of smaller pieces to start the fire. All wood, including kindling, is then weighed and set to the side of the stove.

4. The pots to be used are weighed and their weight recorded. Approximately 3 kg of water are added to the pot and the total weight of pot plus water is recorded.

5. The wood is then arranged in the stove, a small (1-2 ml) amount of kerosene is added to the wood, and the wood set on fire. While the fire becomes established (a minute or so), the water temperature is taken. Once the fire is burning well, the pot is placed on the stove, and a stopwatch is started.

6. The temperature of the water is recorded every five minutes until the first pot begins to boil. The wood is pushed in or added in order to maintain a reasonably steady, but not excessively large, fire. Despite the vagueness of this desired fire size, it can be seen that for the range of firepowers tested there was very little correlation if any with the PHU. It should be noted that no lids are used on any of the pots at any time. Not using lids does increase the necessary firepower for the boiling and particularly for the simmering phases.

7. As soon as the water starts to boil in the first pot (do not wait for the second pot), the flames are blown out; the wood left in the stove is weighed and recorded; and the pots are then weighed and weights recorded. Charcoal is left in the stove unweighed until the end of the simmering phase.

8. After all wood and pot weights are taken and recorded, the fire is relit, the water tempeatures recorded, the pots returned to the stove, and the timing begun again.

9. The temperatures of the pots are again recorded every five minutes. The fire is maintained at a steady level to keep the water temperature above 95°C but below a vigorous boil. Again, lids are not used on the pots.

10. After 60 minutes, the fire is again blown out and the weights of the wood, charcoal, and pots taken and recorded.

11. A sample test sheet is shown in section IV.

It should be noted that this procedure does not provide a good resolution of the high power and low power abilities of the stove; since pot lids are not used, there is a high rate of heat loss from the pot. In order to keep temperatures close to boiling under these circumstances, the tester is obliged, even during the second part of the test—the "low power" simmering phase—to maintain a fairly high power level. This is to be contrasted with the newly released draft international standards which very specifically focus the second, simmering phase of the test on the low power capabilities of the stove. Tests following the draft world standard have been recently done and will be published elsewhere.

Calculating the Percent Heat Utilized

The procedure used for calculating the percent heat utilized (PHU) has already been discussed in the Introduction as well as in the October and February reports. Error analyses can also be found there.

In more detail, the first half efficiency, or PHU, not including charcoal, is given for pot A by:

$$NA' = \frac{0.004186(C-B)(F-E) + 2.26(C-I)}{17.15(D-H)} \times 100\%$$

where the letters refer to the line items on the sample test sheet in section IV or in the data tables.

Similarily, we can write the following equation for the second half efficiency not including charcoal:

$$NA'' = \frac{0.004186(I-B)(F-J) + 2.26(I-M)}{17.15(H-K)} \times 100\%$$

Similar expressions can be generated for other pots. Average efficiencies are given by taking the values at the very start and the very end of the test. Total efficiencies are given by the sums of individual pot efficiencies. Efficiencies including charcoal are given as indicated in the introduction. Unlike previous reports, efficiencies including charcoal for the boiling and simmering phases were not calculated separtately.

The firepower during the first and second stages was also calculated with and without taking charcoal into account. In general, the firepower can be expressed, taking charcoal into account, as:

$$P = \frac{17.15W - 29.00C}{60(\text{elapsed time in minutes})}$$

where P is given in units of kilowatt hours. In terms of the sample test sheet, dividing the charcoal equally between the first and second stages, we find, for example:

$$P_c' = \frac{17.15(D-H) - 14.50(L)}{60(G)}$$

The other values can be derived similarly.

SAMPLE LABORATORY TEST DATA SHEET

Test Number "A" Date ______

Name of tester ______ Weather conditions ______

Type of pots ______ Time ______

Stove ______

START:

Weight of pot A "B"* Weight of pot A and water "C"

Weight of pot B "O" Weight of pot B and water "P"

Weight of pot C "X" Weight of pot C and water "Y"

Weight of wood "D"

BOILING PHASE:

Time	Elapsed time	Water temperatures Pot A	Pot B	Pot C	Remarks
	0	"E"	"Q"	"Z"	
	5				
	10				
	15				
	20				
	25				
	"G"**	"F"*	"R"*	"AA"*	
	30				
	35				
	40				
	45				

Weight of wood remaining "H"

Weight of pot A and water "I"

Weight of pot B and water "S"

Weight of pot C and water "AB"

* Note that all weights are recorded in grams, all temperatures are recorded in degrees centigrade.

**Note that this is the time and water temperature when the first pot reaches a boil.

SIMMERING PHASE:

Time	Elapsed time	Water temperatures Pot A	Pot B	Pot C	Remarks
	0	"J"	"T"	"AC"	
	5				
	10				
	15				
	20				
	25				
	30				
	35				
	40				
	45				
	50				
	55				
	60		"U"	"AD"	

Weight of wood remaining "K"

Weight of charcoal remaining "L"

Weight of pot A and water "M"

Weight of pot B and water "V"

Weight of pot C and water "AE"

REMARKS:

TABLE VII

LABORATORY WATER BOILING TEST DATA AND RESULTS

THREE STONE STOVE

A	B	C	D	E	F	G	H	I	J	K	L	M
7	1292	4286	3230	27	100	30	2525	4015	87	1410	109	2590
33	1455	4514	3295	20	98	35	2354	4103	80	862	111	2541
44	1329	4550	3370	23	98	15	2675	4373	85	1362	105	2775
45	1418	4460	3168	22	98	17	2299	4276	84	1486	102	2929
54	1410	4271	3451	21	98	27	2799	4026	79	1481	130	2530
79	1360	4243	3080	19	100	55	1600	3564	78	98	603	2228
105	1457	4434	3506	21	98	18	2837	4201	82	1582	149	2733
106	1355	4340	3437	22	99	28	2751	4057	80	1618	111	2591
111	1391	4320	2396	22	99	20	1821	4117	80	688	101	2810

A	P_c	N'	P_c	N"	N_o	N_c
7	5.84	12.6	4.87	17.6	15.7	17.5
33	6.92	11.9	6.66	14.6	13.6	14.7
44	11.6	11.8	5.83	16.8	15.1	16.5
45	14.6	9.27	3.87	23.0	15.3	17.1
54	5.74	13.2	5.76	15.9	15.0	16.9
79	5.04	9.90	4.73	12.5	11.2	17.0
105	8.62	12.9	5.38	16.3	15.1	17.4
106	6.04	13.6	4.95	18.2	16.4	18.3
111	7.00	14.2	4.99	16.3	15.6	17.3

Caption headings A through M are taken from the sample tests sheet. The values P_c, N', P_c, N", N_o, and N_c are calculated as described in the text. P_c is the fire power including charcoal remaining during the boiling phase. P_c is the corresponding fire power including charcoal during the second phase. N', N", and N_o are the PHUs of the stove taking into account the charcoal remaining at the end of the test.

FIRED CLAY STOVE

A	B	C	D	E	F	G	H	I	J	K	L	M
25	1272	4618	3491	22	98	15	3145	4452	81	2435	15	2455
35	1287	4306	2807	22	98	12	2501	4128	81	1818	16	2432
37	1279	4263	3029	21	99	14	2741	4100	81	1960	16	2164
42	1279	4214	3531	25	98	15	3156	4056	82	2511	17	2344
47	1276	4134	3448	23	100	12	3156	3980	78	1986	46	1399
55	1289	4319	3308	22	100	15	3009	4172	86	2202	24	2092
68	1291	4277	2225	23	100	15	1926	4117	87	1173	26	2381
72	1393	4406	2065	19	99	18	1702	4203	81	870	23	2374
78	1464	4406	3493	20	98	27	3030	4114	84	2083	40	20[illegible]7
84	1273	4292	3438	23	98	14	3094	4123	81	2450	13	2362

A	P_c	N'	P_c	N"	N_o	N_c
25	6.35	24.3	3.32	38.9	34.1	35.0
35	6.97	26.0	3.19	34.4	31.8	32.7
37	5.60	27.2	3.66	34.3	32.3	33.2
42	6.87	19.5	3.00	36.7	30.3	31.2
47	6.03	25.3	5.39	30.3	29.3	31.0
55	5.31	25.8	3.75	35.2	32.6	33.9
68	5.28	25.8	3.48	31.6	29.9	31.2
72	5.46	23.6	3.87	30.5	28.4	29.3
78	4.54	20.4	4.35	29.3	26.4	27.7
84	6.80	22.5	3.02	37.9	32.5	33.3

NOUNA 31

A	B	C	D	E	F	G	H	I	J	K	L	M
6	1530	4683	3325	27	100	21	2695	4404	86	1458	90	2809
22	1549	4486	3090	20	100	19	2439	4246	75	1183	95	2674
30	1663	4722	3021	20	98	27	2264	4392	75	1165	97	3215
40	1644	4629	3663	21	98	20	2965	4397	79	1501	133	2604
48	1662	4732	3090	22	99	17	2427	4548	81	1180	80	3077
62	1527	4585	3588	22	98	22	2903	4340	73	1260	135	2416
69	1644	4685	3604	19	98	38	2623	4234	84	1237	133	2501
87	1547	4697	3614	21	100	17	2854	4490	86	1543	127	3028
98	1595	4591	3482	21	98	21	2698	4336	76	1003	148	2362
103	1656	4666	3418	22	98	30	2711	4367	76	1204	172	2567

A	P_c	N'	P_c	N"	N_o	N_c
6	7.54	14.7	5.53	17.8	16.8	18.2
22	8.59	13.7	5.60	17.8	16.4	17.9
30	7.15	13.4	4.84	15.5	14.7	16.1
40	8.37	12.4	6.44	17.0	15.5	17.3
48	10.0	12.4	5.62	16.6	15.1	16.3
62	7.42	13.0	7.28	16.5	15.5	17.1
69	6.53	12.0	6.07	17.1	15.0	16.6
87	11.0	11.6	5.73	15.5	13.5	15.1
98	8.97	11.5	7.48	16.2	14.7	16.4
103	5.35	13.5	6.49	16.7	15.7	18.0

METAL STOVE

A	B	C	D	E	F	G	H	I	J	K	L	M
128	1413	4454	2897	$\bar{2}4$	99	13	2538	4282	85	1390	97	2055
129	1527	4578	2810	20	99	12	2442	4428	82	1167	84	1600
130	1394	4374	3445	22	99	14	3117	4197	80	2147	52	2268
131	1396	4341	2506	22	98	14	2112	4206	72	1495	58	2727
132	1390	4415	2679	22	98	14	2250	4106	87	1208	64	1960
133	1237	4235	2380	22	98	11	1980	4037	90	1071	42	1985
134	1417	4417	2941	20	99	10	2500	4165	93	1468	36	1973
135	1396	4396	3175	21	99	12	2793	4164	83	1805	59	2019
136	1346	4347	3199	20	99	11	2732	4016	81	1720	81	1962

A	P_c	N'	P_c	N"	N_o	N_c
128	6.09	21.8	5.08	26.4	25.3	28.4
129	7.07	21.4	5.74	30.2	28.2	30.9
130	5.80	24.2	4.41	27.5	26.7	28.6
131	7.04	18.4	2.71	34.5	28.2	31.2
132	7.65	22.6	4.71	27.8	26.3	28.4
133	9.47	20.4	4.16	30.3	27.3	28.9
134	11.7	20.5	4.77	28.4	26.1	27.2
135	7.91	22.9	4.47	29.7	27.8	30.0
136	10.4	21.7	4.49	27.9	26.0	28.6

AIDR 2

A	B	C	D	E	F	G	H	I	J	K	L	M
1	1292	4316	2912	28	100	27	2152	3975	83	580	126	2110
8	1363	4423	3760	25	100	20	3060	4211	92	1273	124	2204
15	1403	4501	3559	21	98	30	2661	4205	87	1274	94	2473
23	1276	4273	3080	36	98	25	2223	4320	82	695	127	2384
26	1295	4265	3494	22	100	32	2711	4018	83	1179	127	2289
36	1452	4459	3341	20	98	17	2538	4278	82	945	145	2373
49	1278	4291	3504	23	98	20	2633	4067	78	983	111	2178
60	1450	4420	3468	22	98	26	2691	4117	80	1294	79	2445
77	1320	4315	3237	20	100	23	2483	4094	84	558	188	1913
81	1367	4253	3229	18	99	23	2474	3951	74	270	234	1590

A	O	P	Q	R	S	T	U	V
1	1363	4375	28	64	4317	59	90	3861
8	1270	4344	27	62	4300	61	90	3703
15	1370	4365	21	67	4289	62	74	3834
23	1455	4586	36	67	4192	61	85	3693
26	1454	4436	22	58	4396	51	82	4043
36	1351	4028	20	73	3963	61	84	3457
49	1351	4389	22	67	4327	58	81	3766
60	1291	4152	22	63	4077	52	72	3623
77	1273	4416	19	76	4362	61	96	3712
81	1389	4314	18	68	4250	53	88	3498

A	P'	NA'	NB'	P"	NA"	NB"	NAo	NBo	No	Pc'	Pc"	NAc	NBc	Nc
1	8.05	12.9	4.49	7.49	16.3	5.24	15.2	5.00	20.2	6.92	6.98	16.8	5.50	22.3
8	10.0	12.0	4.58	8.51	15.1	5.60	14.2	5.31	19.5	8.51	8.01	15.5	5.80	21.3
15	8.56	10.8	4.86	6.61	17.0	4.94	14.6	4.91	19.5	7.80	6.23	15.7	5.27	20.9
23	9.80	4.57	8.82	7.28	17.5	5.35	12.8	6.60	19.4	8.57	6.77	14.1	7.25	21.4
26	6.99	11.4	4.02	7.30	15.6	4.49	14.2	4.33	18.5	6.03	6.79	15.6	4.77	20.4
36	13.5	10.1	5.38	7.59	16.5	5.11	14.3	5.20	19.5	11.4	7.00	16.0	5.79	21.7
49	12.4	9.72	4.77	7.86	15.9	5.49	13.8	5.24	19.0	11.1	7.41	14.9	5.66	20.5
60	8.54	12.2	4.96	6.66	16.6	5.26	15.0	5.15	20.2	7.81	6.34	16.0	5.49	21.5
77	9.37	11.6	6.74	9.17	15.5	5.82	14.4	6.08	20.5	7.40	8.41	16.3	6.90	23.2
81	9.38	12.8	5.84	10.5	14.8	5.60	14.3	5.67	20.0	6.92	9.56	16.5	6.54	23.1

The caption headings "A" through "V" refer to the sample test sheet as before. P' and P" are the first and second phase firepowere not taking into account the charcoal remaining at the end of the test, while P_c and P_c are the first and second phase firepowers taking the charcoal into account. NA', NB', NA", and NB" are the first and second phase efficiencies for pots A and B not taking the remaining charcoal into account. NA_o, NB_o, and N_o are the average pot A, pot B and total efficiencies over the entire test not taking the charcoal into account. P_c and P_c are the first and second phase firepowers where the charcoal remaining at the end of the test is divided into two equal parts and subtracted from each phase. NA_c, NB_c, and Nc are the total (both phases) pot A, pot B and the total (sum of pot A and pot B) efficiencies (or PHU_c) when the quantity of charcoal remaining at the end of the test is taken into account.

BANFORA

A	B	C	D	E	F	G	H	I	J	K	L	M
2	1350	4752	3574	22	100	24	2783	4504	90	1593	168	2846
17	1350	4251	3242	21	100	28	2536	3890	63	1006	193	2140
11	1353	4427	3441	24	100	19	2882	4246	80	1517	182	2525
28	1416	4474	3564	20	98	28	2746	4195	83	1365	216	2445
38	1348	4480	3477	20	98	23	2616	4268	81	1269	178	2398
52	1278	4392	3334	21	100	23	2506	4155	75	796	336	2335
64	1453	4470	3213	24	99	27	2492	4196	82	1115	222	2397
74	1319	4209	3050	20	98	26	2286	3830	75	876	194	2106
89	1272	4376	3402	24	98	17	2735	4167	83	1265	248	2350
95	1265	4377	3548	22	98	30	2672	4014	83	1229	281	2323

A	O	P	Q	R	S	T	U	V
2	1451	4527	22	71	4462	68	86	3898
17	1293	4169	21	66	4086	43	88	3458
11	1275	4215	24	57	4182	52	82	3653
28	1353	4445	20	61	4397	59	83	3927
38	1414	4307	22	66	4247	61	81	3636
52	1450	4562	21	77	4468	65	95	3717
64	1410	4508	24	62	4464	57	90	3952
74	1396	4389	20	68	4304	61	83	3360
89	1319	4294	24	60	4248	58	90	3561
95	1344	4307	22	66	4231	61	83	3665

A	P'	NA'	NB'	P"	NA"	NB"	NAo	NBo	No	Pc'
2	9.42	12.3	5.73	5.67	19.0	7.36	16.3	6.71	23.0	7.73
17	7.21	14.7	6.02	7.29	16.6	7.41	16.0	6.97	22.9	5.54
11	8.41	14.5	5.01	6.50	17.6	6.67	16.7	6.19	22.9	6.09
28	8.35	11.6	4.55	6.58	17.4	5.78	15.3	5.32	20.6	6.49
38	10.7	10.2	4.53	6.42	19.2	7.00	15.7	6.04	21.7	8.83
52	10.3	11.0	6.63	8.15	15.1	7.08	13.7	6.93	20.7	6.76
64	7.63	12.7	4.79	6.56	18.0	6.69	16.2	6.03	22.2	5.65
74	8.40	13.7	6.05	6.72	17.1	9.93	15.9	8.57	24.5	6.60
89	11.2	12.5	4.83	7.00	17.0	7.71	15.6	6.81	22.4	7.69
95	8.35	12.0	4.77	6.87	16.1	6.24	14.6	5.69	20.3	6.08

Pc"	NAc	NBc	Nc
4.99	19.1	7.83	26.9
6.51	18.7	8.17	26.9
5.77	19.9	7.36	27.3
5.71	18.3	6.38	24.7
5.70	18.1	6.9[illegible]	25.1
6.79	17.7	8.93	26.6
5.67	19.7	7.35	27.1
5.94	18.8	10.1	28.8
6.00	19.4	8.48	27.9
5.74	18.4	7.15	25.5

A	B	C	D	E	F	G	H	I	J	K	L	O
117	2207	5157	3612	22	99	25	2946	4867	79	1167	103	4613
118	2201	5208	3092	22	99	18	2403	4987	82	775	55	4382
119	2194	5484	3226	24	98	20	2512	5279	83	531	136	4221
120	2285	5506	3534	22	99	22	2789	5370	83	1272	116	3349
121	2208	5400	3398	22	99	20	2687	4842	77	973	150	2936
124	2201	5541	3249	20	99	24	2562	5256	83	959	144	3281
125	2227	5282	3691	24	98	23	3147	5031	84	1805	111	3403
126	2276	5538	3670	20	99	23	2961	5278	78	1570	126	3456

A	O	P	Q	R	S	T	U	V
117	2287	5308	22	45	5269	42	81	4432
118	2279	5281	23	48	5236	45	61	4103
119	2282	5514	24	48	5473	47	77	5156
120	2198	5488	22	54	5435	51	78	4993
121	2294	5200	22	44	5161	41	70	4759
124	2277	5521	20	44	5476	41	89	4879
125	2218	5165	24	49	5120	45	90	4547
126	2199	5372	20	47	5330	39	73	4987

A	P'	NA'	NB'	P"	NA"	NB"	NAo	NBo	No	Pc'
117	7.61	14.1	3.32	8.47	2.61	7.79	5.73	6.58	12.3	6.62
118	10.9	12.4	3.52	7.76	5.61	9.88	7.63	7.99	15.6	10.2
119	10.2	12.1	3.41	9.44	7.61	3.29	8.80	3.32	12.1	8.56
120	9.68	10.5	4.39	7.23	18.3	5.25	15.8	4.96	20.7	8.41
121	10.2	18.8	2.92	8.17	15.5	4.27	16.4	3.88	20.3	8.35
124	8.18	14.8	3.63	7.64	17.0	7.24	16.3	6.16	22.5	6.73
125	6.76	16.2	4.39	6.39	16.7	8.00	16.6	6.96	23.5	5.59
126	8.81	13.7	3.73	6.63	18.4	5.12	16.8	4.65	21.4	7.49

Pc"	NAc	NBc	Nc
8.06	6.17	7.08	13.2
7.53	7.95	8.32	16.3
8.89	9.62	3.63	13.2
6.76	17.3	5.43	22.7
7.56	18.4	4.33	22.7
7.06	18.3	6.89	25.2
5.95	18.4	7.73	26.1
6.12	18.7	5.17	23.9

KAYA 2

A	B	C	D	E	F	G	H	I	J	K	L	M
3	1398	4531	3124	31	100	42	2007	4097	84	885	81	2730
9	1393	4304	3277	26	100	35	2320	3925	87	618	145	2408
16	1354	4497	3388	22	100	25	2229	4262	84	546	159	2625
18	1270	4256	3417	20	98	35	2152	3879	72	792	106	2378
27	1323	4342	3351	20	98	45	2157	3933	79	390	155	2246
46	1393	4316	3533	24	98	42	2250	3843	81	809	154	2333
57	1347	4358	3780	21	100	29	2355	4033	77	486	233	2243
73	1292	4370	3047	18	100	37	1710	3940	78	255	153	2219
86	1284	4287	3550	21	98	28	2249	3925	78	863	115	2301
97	1407	4509	3494	21	98	61	2067	3527	70	1069	207	2339

A	O	P	Q	R	S	T	U	V
3	1280	4420	31	71	4309	68	76	3974
9	1276	4206	25	67	4115	65	83	3520
16	1270	4257	24	84	4118	75	86	3436
18	1450	4430	23	77	4231	65	72	3709
27	1400	4546	19	71	4447	64	89	3807
46	1449	4340	24	76	4176	68	75	2693
57	1316	4346	21	87	4165	64	88	3450
73	1272	4362	18	86	4197	72	84	3529
86	1390	4301	22	77	4118	65	72	3582
97	1341	4472	21	62	4324	59	76	3960

A	P'	NA'	NB'	P"	NA"	NB"	NA_o	NB_o	N_o	P_c
3	7.60	9.84	4.05	5.35	17.0	4.46	13.4	4.26	17.7	7.14
9	7.82	10.7	4.39	8.11	12.2	5.34	11.7	5.00	16.7	6.81
16	13.3	7.83	5.35	8.02	13.5	5.79	11.2	5.61	16.8	11.7
18	10.3	8.42	5.18	6.48	15.8	5.41	12.2	5.30	17.5	9.60
27	7.58	9.33	4.44	8.42	13.3	5.82	11.7	5.26	16.9	6.75
46	8.73	8.97	4.54	6.86	14.5	13.9	11.9	9.49	21.4	7.85
57	14.0	7.08	5.10	8.90	13.4	5.93	10.7	5.57	16.3	12.1
73	10.3	8.84	5.46	6.93	16.6	6.64	12.9	6.07	18.9	9.33
86	13.3	8.00	4.86	6.60	16.4	5.43	12.3	5.15	17.5	12.3
97	6.69	13.2	3.56	4.75	17.1	6.05	14.8	4.58	19.4	5.87

P_c	NA_c	NB_c	N_c
5.02	14.3	4.53	18.8
7.52	12.9	5.51	18.4
7.38	12.4	6.20	18.6
6.05	13.1	5.68	18.8
7.79	12.8	5.78	18.6
6.24	13.2	10.5	23.6
7.97	12.1	6.33	18.5
6.32	14.2	6.69	20.9
6.14	13.3	5.56	18.8
3.92	17.3	5.36	22.6

NOUNA 2

A	B	C	D	E	F	G	H	I	J	K	L	M
4	1464	4675	3553	26	100	33	2595	4314	88	851	0	2597
13	1454	4497	3663	22	98	29	2928	4417	94	1202	162	2384
19	1460	4502	3612	22	98	44	2699	4084	76	1231	86	2384
31	1370	4366	3408	20	100	30	2545	4026	74	901	124	2309
51	1462	4420	3194	21	98	22	2454	4203	80	910	139	2440
66	1280	4387	3445	22	98	27	2320	4137	79	1197	119	2574
76	1395	4413	3554	20	99	25	2655	4135	87	1176	140	2368
88	1290	4332	3517	25	98	20	2737	4127	81	1309	117	2524
94	1358	4426	3671	20	97	22	2865	4198	77	1269	174	2541
102	1391	4420	3554	20	99	30	2775	4108	78	1361	101	2474

A	O	P	Q	R	S	T	U	V
4	1324	4500	26	72	4393	68	92	3686
13	1414	4392	22	63	4344	57	87	3632
19	1318	4494	22	78	4372	61	83	3393
31	1330	4285	19	65	4214	57	98	3486
51	1344	4421	21	64	4381	59	84	3770
66	1346	4384	23	70	4320	63	83	3746
76	1362	4446	20	58	4359	66	82	3826
88	1295	4338	24	66	4279	64	84	3607
94	1388	4507	20	68	4446	59	89	3796
102	1286	4335	20	63	4271	58	78	3786

A	P'	NA'	NB'	P"	NA"	NB"	NAo	NBo	No	Pc'
4	8.30	11.0	5.19	8.31	13.5	6.37	12.6	5.95	18.5	8.30
13	7.24	9.11	4.91	8.22	15.7	6.68	13.7	6.15	19.9	5.89
19	5.93	12.2	6.51	6.99	16.2	9.90	14.7	8.60	23.3	5.46
31	8.22	12.0	4.93	7.83	14.8	7.59	13.8	6.67	20.5	7.22
51	9.61	11.4	5.07	7.36	15.8	6.41	14.4	5.98	20.4	8.09
66	11.9	8.05	3.85	5.35	19.5	8.03	13.8	5.94	19.7	10.8
76	10.3	10.5	4.46	7.05	16.3	5.54	14.1	5.13	19.2	8.93
88	11.1	10.4	4.99	6.80	15.6	7.22	13.8	6.43	20.2	9.73
94	10.5	10.9	5.53	7.60	14.5	6.77	13.3	6.35	19.7	8.56
102	7.42	12.8	5.19	6.74	16.2	5.55	15.0	5.42	20.4	6.61

Pc"	NAc	NBc	Nc
8.31	12.6	5.95	18.5
7.57	15.4	6.92	22.4
6.65	15.6	9.16	24.8
7.33	15.1	7.28	22.4
6.80	16.0	6.67	22.7
4.87	15.1	6.52	21.7
6.48	15.7	5.70	21.4
6.33	15.1	7.07	22.2
6.90	15.2	7.24	22.4
6.33	16.3	5.88	22.1

NOUNA 32

A	B	C	D	E	F	G	H	I	J	K	L	M
10	1460	4154	3032	24	98	30	2311	3792	78	568	152	2119
14	1355	4492	3212	21	100	23	2422	4293	85	953	140	2702
21	1296	4519	3131	21	98	26	2406	4269	76	891	170	2377
34	1279	4461	3258	23	98	18	2570	4260	77	1136	121	2642
43	1399	4203	3376	25	100	15	2720	3962	75	242	350	1579
50	1366	4416	3592	21	98	17	2608	4205	78	1296	165	2638
63	1298	4299	3206	22	98	30	2376	3910	64	877	200	2334
71	1459	4483	3185	19	98	25	2294	4207	84	877	153	2481
90	1370	4372	3272	24	99	23	2434	4099	78	1184	123	2525
104	1342	4339	3659	20	98	39	2909	4010	86	1597	142	2470

A	O	P	Q	R	S	T	U	V
10	1397	4130	26	56	4068	52	77	3610
14	1277	4297	21	63	4252	57	81	3855
21	1354	4470	20	48	4440	42	80	4403
34	1400	4126	23	61	4079	52	83	3696
43	1293	4220	24	59	4182	55	97	3419
50	1394	4429	21	69	4378	62	76	3935
63	1398	4382	22	62	4293	48	75	3888
71	1410	4525	19	60	4466	56	76	4021
90	1357	4315	24	66	4302	60	73	3818
104	1271	4279	22	48	4245	45	68	3937

A	P'	NA'	NB'	P"	NA"	NB"	NAo	NBo	No	Pc'
10	6.87	13.4	3.91	8.30	13.3	4.40	13.3	4.25	17.6	5.65
14	9.82	11.0	4.67	7.00	15.0	4.75	13.6	4.72	18.3	8.35
21	7.97	12.9	3.48	7.22	17.5	2.21	16.0	2.62	18.6	6.39
34	10.9	12.3	4.57	6.83	15.9	4.93	14.8	4.82	19.6	9.30
43	12.5	12.7	4.57	11.8	13.3	5.25	13.2	5.11	18.3	6.86
50	16.5	8.65	4.29	6.25	16.8	5.23	13.3	4.83	18.1	14.2
63	7.91	12.9	4.92	7.14	15.3	4.83	14.4	4.86	19.3	6.30
71	10.2	10.6	4.37	6.75	16.7	5.19	14.4	4.87	19.2	8.71
90	10.4	10.8	3.82	5.95	17.7	5.85	15.0	5.04	20.0	9.12
104	5.50	13.4	3.14	6.25	16.1	4.37	15.1	3.92	19.0	4.62

Pc"	NAc	NBc	Nc
7.69	14.9	4.75	19.6
6.43	15.2	5.27	20.5
6.53	18.4	3.01	21.4
6.34	16.3	5.33	21.7
10.4	16.2	6.30	22.5
5.59	15.1	5.49	20.6
6.34	16.9	5.69	22.6
6.13	16.2	5.49	21.7
5.46	16.6	5.59	22.2
5.68	17.1	4.44	21.5

TITAO

A	B	C	D	E	F	G	H	I	J	K	L	M
67	1392	4436	4555	22	98	43	2990	3952	80	384	452	2054
70	1348	4390	4341	19	98	50	2471	3727	79	782	268	2283
83	1359	4462	3535	19	98	50	1701	3922	74	386	287	2585
92	1462	4535	3719	22	93	30	2334	4093	78	721	323	2866
93	1286	4329	4600	18	98	55	2385	3605	78	90	517	1598
109	1450	4522	3595	24	98	45	2425	3985	81	939	278	2994
100	1449	4424	3445	25	99	37	2541	4173	78	795	269	3092
101	1388	4408	4199	21	95	55	2473	3809	80	444	288	2358
112	1285	4130	4698	23	98	53	2748	3436	79	1357	267	2236
113	1448	4478	3984	20	92	60	2052	3845	72	407	323	2612

A	O	P	Q	R	S	T	U	V
67	1458	4446	22	68	4317	63	92	3690
70	1450	4519	19	68	4167	59	68	3745
83	1406	4522	22	74	4318	58	65	3969
92	1397	4423	22	69	4313	68	68	3953
93	1272	4225	18	78	3936	68	86	3186
109	1278	4339	24	63	4435	50	68	4147
100	1361	4429	25	57	4362	47	63	4060
101	1341	4348	22	66	4176	59	66	3648
112	1312	4228	24	72	4039	65	65	3615
113	1359	4319	20	67	4075	62	69	3631

A	P'	NA'	NB'	P"	NA"	NB"	NAo	NBo	No	Pc'
67	10.4	7.68	3.23	12.4	10.0	3.95	9.15	3.68	12.8	7.86
70	10.7	7.81	4.44	8.05	11.9	3.65	9.76	4.00	13.8	9.39
83	10.5	7.14	3.62	6.26	14.5	3.88	10.2	3.73	14.0	9.10
92	13.2	8.05	3.55	7.68	10.6	2.94	9.43	3.22	12.7	10.6
93	11.5	6.99	3.67	10.9	12.0	4.82	9.55	4.25	13.8	9.24
109	7.43	10.8	1.41	7.08	9.50	3.49	10.1	2.57	12.6	5.94
100	6.98	9.60	3.63	8.32	8.96	2.95	9.18	3.18	12.4	5.23
101	8.97	7.73	3.18	9.67	9.86	3.67	8.88	3.45	12.3	7.70
112	10.5	7.36	3.03	6.63	12.1	4.02	9.33	3.44	12.8	9.30
113	9.20	7.07	3.42	7.84	10.6	3.84	8.69	3.61	12.3	7.90

Pc"	NAc	NBc	Nc
10.6	11.2	4.50	15.7
6.97	11.2	4.59	15.8
5.11	12.1	4.41	16.5
6.38	11.5	3.94	15.5
8.85	11.8	5.28	17.1
5.96	12.2	3.12	15.4
7.23	11.1	3.84	14.9
8.51	10.2	3.96	14.2
5.55	10.8	3.98	14.8
6.54	10.3	4.26	14.5

AIDR 3

A	B	C	D	E	F	G	H	I	J	K	L	M
5	1414	4457	3112	27	100	27	2161	4241	85	397	160	2466
12	1379	4890	3774	21	98	23	2610	4303	82	91	223	1649
24	1414	4456	3340	26	99	18	2491	4266	82	878	163	2469
29	1463	4531	3967	20	98	18	3175	4354	77	1225	188	2380
41	1462	4293	3392	20	98	20	2532	4047	89	151	294	1812
56	1282	4310	4374	22	98	15	3284	4095	80	896	267	1726
65	1322	4297	3249	24	99	15	2310	4068	70	318	192	1912
80	1352	4415	3921	20	98	30	2857	4023	76	912	211	2032
91	1447	4423	3256	22	99	30	2289	4029	80	566	128	2135
108	1392	4398	3786	23	98	21	3081	4250	84	1385	205	2315

A	O	P	Q	R	S	T	U	V
5	1270	4371	27	61	4328	61	81	3857
12	1408	4354	21	67	4278	62	84	3523
24	1319	4343	26	57	4308	55	75	3927
29	1350	4411	20	49	4385	46	82	3973
41	1395	4416	20	49	4385	48	82	3831
56	1398	4395	22	68	4349	52	92	3586
65	1348	4365	23	62	4307	53	82	3703
80	1296	4332	20	55	4275	49	76	3814
91	1460	4540	23	55	4465	50	68	4028
108	1412	4445	24	47	4421	46	72	4103

A	X	Y	Z	AA	AB	AC	AD	AE
5	1660	4664	27	43	4636	41	63	4446
12	1649	4959	22	47	4917	45	72	4561
24	1660	4680	26	43	4654	42	59	4493
29	1535	4648	20	38	4622	36	61	4449
41	1532	4666	20	36	4646	34	68	4408
56	1661	4588	22	46	4559	38	72	4227
65	1647	4345	23	44	4309	41	63	4059
80	1533	4659	20	40	4616	38	61	4394
91	1660	4697	23	43	4646	39	55	4424
108	1644	4640	24	36	4622	35	54	4474

A	P'	NA'	NB'	NC'	P"	NA"	NB"	NC"
5	10.1	8.69	3.30	1.62	8.40	13.8	4.36	2.32
12	14.5	12.3	3.70	2.21	12.0	14.3	4.56	2.72
24	13.5	9.33	3.24	1.88	7.68	15.4	4.02	2.09
29	12.6	10.3	3.17	2.16	9.29	14.1	4.15	2.13
41	12.3	10.0	2.96	1.73	11.3	12.6	4.11	2.40
56	20.8	7.75	3.64	1.92	11.4	13.6	5.42	2.84
65	17.9	9.01	3.87	1.98	9.49	15.2	5.05	2.37
80	10.1	10.3	3.14	1.97	9.27	14.2	4.13	2.39
91	9.21	11.2	3.51	2.23	8.21	15.2	4.11	2.37
108	9.60	10.6	2.86	1.58	8.08	15.6	3.60	1.96

A	NAo	NBo	NCo	No	Pc'	Pc"	NAc	NBc	NCc	Nc
5	12.0	3.99	2.08	18.1	8.64	7.76	13.4	4.43	2.31	20.1
12	13.7	4.29	2.56	20.5	12.1	11.1	15.3	4.78	2.85	22.9
24	13.3	3.75	2.01	19.1	11.3	7.03	15.0	4.22	2.27	21.5
29	13.0	3.87	2.14	19.0	10.1	8.53	14.7	4.37	2.42	21.5
41	11.9	3.80	2.22	18.0	8.74	10.2	14.1	4.49	2.63	21.2
56	11.8	4.86	2.55	19.2	16.5	10.3	13.5	5.59	2.93	22.0
65	13.2	4.67	2.24	20.2	14.8	8.72	14.9	5.25	2.52	22.7
80	12.8	3.78	2.24	18.9	8.44	8.42	14.6	4.29	2.54	21.4
91	13.7	3.89	2.32	19.9	8.18	7.69	14.9	4.23	2.52	21.7
108	14.1	3.38	1.85	19.4	7.24	7.25	16.5	3.95	2.16	22.6

KAYA 3

A	B	C	D	E	F	G	H	I	J	K	L	M
20	1396	4441	5539	22	98	64	3038	3910	69	973	174	3197
32	1415	4187	3633	19	98	33	2708	3872	81	770	221	2319
59	1459	4443	4805	20	98	50	2707	3833	76	571	261	2425
39	1352	4376	3925	21	98	35	2415	3951	71	440	222	2584
75	1280	4309	3704	19	98	25	2583	3977	79	594	298	2417
85	1294	4282	4924	21	98	50	2901	3532	78	331	403	2118
96	1391	4398	4828	22	99	35	2708	3909	83	298	439	2425
107	1268	4274	3256	20	98	50	1896	3799	70	307	270	2314
110	1270	4216	5130	23	98	43	4015	3845	79	2118	231	2460
114	1392	4376	3840	21	99	24	2463	4055	90	597	257	2471

A	O	P	Q	R	S	T	U	V
20	1412	4535	22	68	3602	69	98	2432
32	1296	4076	19	51	4030	49	80	3632
59	1412	4430	23	90	3983	72	97	2783
39	1452	4473	22	76	4286	63	97	3561
75	1348	4413	19	39	4377	37	64	4081
85	1391	4397	22	82	4003	68	98	2968
96	1449	4456	22	84	4123	74	92	2840
107	1314	4431	20	62	4342	50	82	3944
110	1340	4323	22	66	4137	60	89	3536
114	1275	4275	22	71	4185	67	89	3456

A	X	Y	Z	AA	AB	AC	AD	AE
20	1660	4572	22	67	4297	59	74	3928
32	1652	4552	19	49	4500	41	72	4109
59	1642	4448	23	73	4209	63	76	3569
39	1657	4744	21	65	4614	58	81	4157
75	1667	4619	19	56	4541	52	69	4077
85	1647	4664	22	70	4422	58	92	3697
96	1639	4674	22	70	4183	62	78	3820
107	1523	4432	22	60	4341	44	74	3943
110	1533	4479	22	52	4419	49	78	4064
114	1657	4627	22	68	4548	64	69	4023

A	P'	NA'	NB'	NC'	P"	NA"	NB"	NC"
20	11.2	5.06	6.32	2.73	9.84	5.41	8.22	2.82
32	8.01	10.3	3.00	3.04	9.23	11.1	3.77	3.77
59	12.0	6.54	5.16	3.13	10.2	9.28	8.14	4.33
39	12.3	7.47	4.27	3.33	9.41	9.99	6.03	3.89
75	12.8	9.11	1.76	3.29	9.48	11.0	2.96	3.67
85	11.6	7.66	4.74	3.32	12.2	7.68	6.05	4.61
96	17.3	5.70	4.22	4.73	11.5	8.52	7.50	2.40
107	7.77	8.81	3.21	2.86	7.57	13.4	4.79	4.60
110	7.41	9.22	5.07	2.64	9.04	10.3	5.22	3.54
114	16.4	7.20	3.47	3.18	8.89	11.5	5.99	3.90

A	NAo	NBo	NCo	No	Pc'	Pc"	NAc	NBc	NCc	Nc
20	5.22	7.18	2.77	15.2	10.5	9.14	5.58	7.67	2.96	16.2
32	10.8	3.52	3.53	17.9	6.39	8.34	12.4	4.05	4.06	20.6
59	7.92	6.66	3.74	18.3	10.7	9.12	8.84	7.44	4.17	20.5
39	8.90	5.27	3.65	17.8	10.8	8.51	9.97	5.90	4.09	20.0
75	10.3	2.53	3.54	16.4	9.94	8.28	12.3	3.02	4.22	19.5
85	7.67	5.47	4.04	17.2	9.62	10.6	9.00	6.43	4.75	20.2
96	7.20	5.96	3.49	16.7	14.3	9.71	8.62	7.13	4.17	19.9
107	11.3	4.06	3.80	19.1	6.47	6.48	13.4	4.80	4.49	22.7
110	9.87	5.16	3.21	18.2	6.11	8.11	11.3	5.93	3.69	21.0
114	9.67	4.92	3.59	18.2	13.8	7.85	11.2	5.68	4.15	21.0

SAMPLE CONTROLLED COOKING TEST SHEET

Name of tester ____"A"____

Date ____"C"____

Stove ____"B"____

SAUCE:	oil	100	gms
	meat	450	
	garden tomatoes	300	
	tomato paste	50	
	water	2500	
	condiments	50	
	onions	70	
	gumbo	100	
TO:	water	4000	
	flour	1000	
	tamarin water	500	

Start time ________

Weight of sauce pot ____"D"____

Weight of oil ____"E"____

Weight of meat ____"F"____

Weight of tomatoes ____"G"____

Weight of tomato paste ____"H"____

Weight of water ____"I"____

Weight of condiments ____"J"____

Weight of onions ____"K"____

Weight of gumbo ____"L"____

Weight of wood ____"Q"____

Weight of tô pot ____"M"____

Weight of water ____"N"____

Weight of flour ____"O"____

Weight of tamarin ____"P"____

Weight of sauce pot and sauce after cooking ____"R"____

Weight of tô pot and tô after cooking ____"S"____

Weight of remaining wood ____"T____

Finish time ________

Total elapsed time ____"U"____

REMARKS:

TABLE VIII

CONTROLLED COOKING TEST DATA AND RESULTS

A	B	C	D	E	F	G	H	I	J	K	L
ISBL	K3	J19	1349	100	400	300	50	2000	50	70	100
ISBL	N3	J20	1276	100	450	300	50	2000	50	70	100
ISBL	N2	J21	1275	100	450	300	50	2000	50	70	100
ISBL	B	J24	1320	100	450	300	50	2000	50	70	100
ISBL	TRAD	J25	1316	100	450	300	50	2000	50	70	100
ISBL	MTL	J26	1316	100	450	300	50	2000	50	70	100
ISBL	K2	J27	1271	100	450	300	50	2000	50	70	100
ISBL	A2	J28	1280	100	450	300	50	2000	50	70	100
ISBL	A3	J31	1322	100	450	300	50	2000	50	70	100
ISBL	T	F1	1316	100	450	300	50	2000	50	70	100
ISBL	C	F2	2206	100	450	300	50	2000	50	70	100
ALIC	B	F7	1317	100	.450	300	50	2500	52	70	104
ALIC	TRAD	F8	1407	100	450	300	50	2500	50	70	101
ALIC	N2	F11	1274	100	450	300	50	2500	50	70	100
ALIC	MTL	F15	1392	100	450	300	50	2500	50	70	100
ALIC	A3	F16	1410	100	450	300	50	2500	50	70	100
CADI	A3	F7	1520	100	450	300	50	2500	54	70	104
CADI	N2	F8	1456	100	450	300	50	2500	50	70	100
CADI	B	F9	1393	100	450	300	50	2500	50	70	100
CADI	TRAD	F10	1528	100	450	300	50	2500	50	70	100
CADI	MTL	F11	1528	100	450	300	50	2500	50	70	100
CADI	B	F15	1445	100	450	300	50	2500	50	70	100
CADI	MTL	F16	1395	100	450	300	50	2500	50	70	100
CADI	N2	F17	1344	100	450	300	50	2500	50	70	100
TENE	MTL	F7	1234	100	400	300	50	2000	45	70	50
TENE	A3	F8	1394	100	450	300	50	2500	50	50	100
TENE	N2	F9	1407	100	450	300	50	2500	50	70	100
TENE	B	F10	1320	100	450	300	50	2500	50	70	100
TENE	TRAD	F11	1394	100	450	300	50	2500	50	70	100
TENE	TRAD	F15	1288	100	450	300	50	2500	50	70	100
TENE	N2	F16	1235	100	450	300	50	2500	50	70	100
TENE	B	F17	1396	100	450	300	50	2500	50	70	100

Column "B" listing the stove type has the following definitions:

A2, A3 --AIDR 2, 3
B -- Banfora
C -- CATRU
K2, K3 --Kaya 2,3
N2, N32 -- Nouna 2, Nouna 32
MTL -- Metal stove
T -- Titao
Trad -- Traditional three stone stove

Note that the ceramic stove was never tested in cooking performance due to cracking during laboratory testing.

Note that tests, CADI, F11, TENE F7, and TENE F11, are not included in the analysis. Because the quantity of water that was added was too much or too little, the water was either boiled away or other ingredients adjusted to make the meal palatable.

A	C	M	N	O	P	Q	R	S	T	U
ISBL	J19	1294	4002	910	500	3887	3481	5572	391	80
ISBL	J20	1391	4000	904	500	3491	3820	5986	1800	65
ISBL	J21	1407	4000	970	500	3904	3738	6170	2009	55
ISBL	J24	1399	4000	1036	500	2545	3430	6249	628	74
ISBL	J25	1347	4000	1058	500	2686	3490	6316	667	100
ISBL	J26	1343	4000	927	500	3776	3576	6096	2550	90
ISBL	J27	1399	4000	960	500	3392	3619	6191	1344	65
ISBL	J28	1529	4000	905	500	2925	3166	6050	717	70
ISBL	J31	1450	4000	988	500	2506	3391	5998	290	80
ISBL	F1	1395	4000	950	500	3521	3497	5770	576	85
ISBL	F2	2296	3988	910	500	3899	4111	6370	1522	65
ALIC	F7	1290	4000	1000	500	3000	4203	6488	940	61
ALIC	F8	1347	4000	1000	500	3044	3803	6276	754	84
ALIC	F11	1448	4000	1000	500	3000	3642	6433	1085	78
ALIC	F15	1395	4000	1022	500	3000	3536	6403	1746	88
ALIC	F16	1345	4000	1000	500	3000	3723	6099	609	67
CADI	F7	1406	4000	1000	500	3000	4072	6341	915	60
CADI	F8	1524	4000	1000	500	3000	4511	6425	1023	80
CADI	F9	1452	4000	1000	500	3000	4109	6394	1370	89
CADI	F10	1244	4000	1000	500	3000	4142	6181	820	[illegible]
CADI	F11	1346	5000	1250	500	3000	3735	6896	1461	103
CADI	F15	1404	4000	1000	500	3000	4120	6398	1437	80
CADI	F16	1389	4000	1000	500	3000	4061	6267	1748	66
CADI	F17	1290	4000	1000	500	3000	3738	6221	1101	90
TENE	F7	1456	4000	950	500	3000	2658	6416	1626	81
TENE	F8	1392	4000	1000	500	3000	3774	6308	475	69
TENE	F9	1233	4000	1000	500	3000	4027	6150	1261	76
TENE	F10	1275	4000	1000	500	3000	3352	6276	1053	73
TENE	F11	1410	5000	1250	500	3000	3677	7464	1021	93
TENE	F15	1275	4000	1000	500	3000	3837	6324	1036	63
TENE	F15	1393	4000	1000	500	3000	3712	6279	880	85
TENE	F17	1270	4000	1000	500	3000	4204	5963	1103	93

A	B	C	TOT	EVAP	WOOD	SC
ISBL	K3	J19	8482	2072	3496	.511
ISBL	N32	J20	8524	1385	1691	.222
ISBL	N2	J21	8590	1364	1895	.246
ISBL	B	J24	8656	1696	1917	.258
ISBL	TRAD	J25	8678	1535	2019	.265
ISBL	MTL	J26	8547	1534	1226	.164
ISBL	K2	J27	8580	1440	2048	.269
ISBL	A2	J28	8525	2118	2208	.323
ISBL	A3	J31	8608	1991	2216	.314
ISBL	T	F1	8570	2014	2945	.421
ISBL	C	F2	8518	2539	2377	.372
ALIC	B	F7	9126	1042	2060	.239
ALIC	TRAD	F8	9121	1796	2290	.293
ALIC	N2	F11	9120	1767	1915	.244
ALIC	MTL	F15	9142	1990	1254	.164
ALIC	A3	F16	9120	2053	2391	.317
CADI	A3	F7	9128	1641	2085	.261
CADI	N2	F8	9120	1164	1977	.233
CADI	B	F9	9120	1462	1630	.199
CADI	TRAD	F10	9120	1569	2180	.270
CADI	MTL	F11	10370	2613	1539	.186
CADI	B	F15	9120	1451	1563	.191
CADI	MTL	F16	9120	1576	1252	.155
CADI	N2	F17	9120	1795	1899	.243
TENE	MTL	F7	8465	2081	1374	.202
TENE	A3	F8	9100	1804	2525	.324
TENE	N2	F9	9120	1583	1739	.216
TENE	B	F10	9120	2087	1947	.259
TENE	TRAD	F11	10370	2033	1979	.222
TENE	TRAD	F15	9120	1522	1964	.242
TENE	N2	F16	9120	1757	2120	.270
TENE	B	F17	9120	1619	1897	.237

The column captions "A," "B," and "C" are given on the preceding sample tests sheet. "TOT" is the total amount of food--sauce and "tô"--before cooking begins. "EVAP" gives the amount of water evaporated during the test. "WOOD" gives the amount of wood used during the test. "SC" gives the specific consumption defined as the equivalent dry wood consumed divided by the food processed or

$$SC = \frac{\frac{17150}{18322}\text{(WOOD)}}{\text{(TOT - EVAP)}}$$

SAMPLE HEAT RECUPERATION TEST SHEET

Test Number "A" Date "C"

Name of tester ______ Weather ______

Stove "B" Time ______

START:

Weight of pot A "D" Weight of pot A and water "G"

Weight of pot B "E" Weight of pot B and water "H"

Weight of pot C "F" Weight of pot C and water "I"

Time	Elapsed time	Water temperatures Pot A	Pot B	Pot C	Remarks
	0	"J"	"K"	"L"	
	5				
	10				
	15				
	20				
	25				
	30				
	35				
	40				
	45				
	50				
	"P"*	"M"*	"N"*	"O"*	
	55				
	60				
	65				

Weight of wood used during preceding controlled cooking test "Q"

* Time and temperatures chosen for when all temperatures are at their maximums.

TABLE IX

HEAT RECUPERATION TEST DATA AND RESULTS

A	B	C	D	E	F	G	H	I	J	K	L	M
1	N32	J20	1408	1346	0	4400	4245	0	23	24	0	39
2	N2	J21	1394	1315	0	4375	4318	0	20	20	0	39
3	B	J24	1280	1392	0	4268	4356	0	24	23	0	39
4	K2	J27	1295	1235	0	4276	4204	0	27	24	0	37
5	A2	J28	1415	1276	0	4400	4273	0	21	20	0	39
6	A3	J31	1351	1271	1776	4365	4305	4776	24	24	23	36
7	T	F2	1396	1347	0	4409	4323	0	22	22	0	38

N	O	P	Q	R
34	0	45	1691	1.11
36	0	45	1895	1.35
29	0	45	1917	.797
32	0	30	2048	.638
32	0	45	2208	.991
29	35	35	2216	.962
31	0	50	2945	.621

Column captions are given on the preceding sample test sheet. All weights are given in grams and all temperat;ures are given in degrees centigrade. Column "R" gives the percentage of heat given off by burning the wood "Q" during the preceding controlled cooking test that is captured by the pots of cold water placed on the hot stove.

SAMPLE FAMILY COMPOUND BOILING WATER TEST SHEET

Test Number ____"A"____ Date ____________
Name of tester ____"B"____ Weather ____________
Size of pot ____"D"____ Time ____________
Location of stove ____"C"____ Distance, ground to pot ____"F"____
Weight of pot ____"E"____

START:

Weight of pot and water ____"G"____
Weight of wood ____1.000 kilogram____

Time	Elapsed time	Water Temperature	Remarks
____	0	"I"	____
____	5	____	____
____	10	____	____
____	15	____	____
____	20	____	____
____	25	____	____
____	30	____	____
____	35	____	____
	"L"*	"J"*	
____	40	____	____
____	45	____	____
____	50	____	____
____	55	____	____
____	60	____	____
	"M"**	"K"**	
____	65	____	____
____	70	____	____
____	75	____	____

Weight of pot and water at end ____"H"____

* The time to reach boiling and/or the maximum temperature reached.
**The time and temperature when the 1 kg charge of wood is completely burned. Charcoal is not recuperated and left to burn out.

TABLE X

FAMILY COMOUND BOILING WATER TESTS DATA AND RESULTS

A	B	C	D	E	F	G	H	I	J	K	L	M
1	ALICE	1	3	2060	14	4900	4010	23	99	99	15	70
2	ALICE	0	3	2060	12	4600	3750	25	100	100	50	55
3	ALICE	1	3	2060	16	4600	3840	25	100	100	20	45
4	TENE	1	4	2499	10	4900	3800	25	98	90	17	55
5	TENE	0	2	1550	11	4000	3600	25	88	79	0	45
6	TENE	2	4	2620	15	4800	4050	25	98	96	15	33
7	CADIE	1	3	1990	13	4820	3850	27	99	89	22	55
8	CADIE	0	3	1990	15	4850	4350	21	99	93	27	37
9	CADIE	0	2	1700	12	4500	3640	29	99	90	12	47
10	ALICE	1	3	2050	16	4640	3450	26	100	93	15	45
11	ALICE	0	3	2050	16	4550	3700	22	100	90	15	45
12	ALICE	0	3	2050	14	4700	4350	21	89	83	0	45
13	ALICE	1	3	2050	0	4455	3560	25	100	93	15	35
14	CADIE	1	4	2570	16	4890	3970	27	99	85	32	55
15	CADIE	0	4	2680	14	4960	4470	27	92	90	0	30
16	CADIE	0	3	2000	10	4360	3500	25	98	82	22	63
17	CADIE	0	4	2580	18	4800	4250	22	99	90	18	30
18	TENE	1	3	2400	14	4500	3690	23	99	80	19	57
19	TENE	0	2	1950	10	4350	3320	25	99	98	17	52
20	TENE	0	3	2010	13	4510	3910	24	98	94	22	38
21	TENE	0	4	2600	15	4600	3830	27	95	91	0	39
22	ALICE	1	3	2080	16	4660	3640	25	100	90	10	40
23	ALICE	0	3	2065	16	4480	3480	24	97	82	15	45
24	ALICE	0	3	2080	12	4455	3850	21	98	86	25	40
26	TENE	1	2	1650	9	4050	2830	25	98	93	15	68
27	TENE	1	2	1860	10	4010	3080	19	98	91	16	58
28	TENE	0	2	1670	12	4150	3710	23	95	94	0	41
30	CADIE	0	3	2010	11	4740	4160	23	98	96	20	37
31	CADIE	1	3	2000	13	4760	3660	25	98	87	21	57
32	CADIE	1	3	2010	15	4890	4270	25	98	92	24	44

Column captions are given on the preceding sample test sheet. Column "C" gives whether the test was held inside, "1", or outside "0". Column "D" gives the size of the pot and corresponds to the dimensions given previously for different pot sizes. Column "F" gives the height from the ground to the bottom of the pot in centimeters when in place on the three stone fire. All weights above are given in grams and all temperatures are given in degrees centigrade.

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