

DESIGN OF INDICATING SYSTEM
FOR
DOMESTIC GAS CYLINDER

MADHAY N. MARYANKAR

INDUSTRIAL DESIGN CENTRE
INDIAN INSTITUTE OF TECHNOLOGY BOMBAY
1976

**report on design of indicating system
for domestic gas cylinders**

diploma project

m. n. narvankar

industrial design centre

i. i. t., bombay

Design of Indicating System for
Domestic Gas Cylinder

Diploma Project

Submitted in partial fulfillment of the
requirements for the Postgraduate Diploma
in Industrial Design

I. D. C. Library
I. I. T. Bombay.

A. K. Narverkar

I. D. C. Library
I. I. T. Bombay.

The-DP-57



Design of indicating system for

Indian Institute of Technology

Bombay

1975

57

Design of Indicating System for
Domestic Gas Cylinder

Diploma Project

Submitted in partial fulfilment of the
requirements for the Postgraduate Diploma
in Industrial Design

by

M.N. Narvankar

I. D. C. Library
L. I. T. Bombay.

IDC/LIB/DP/6-57/77-78

Industrial Design Centre
Indian Institute of Technology
Bombay

1976

Approval Sheet

Diploma project entitled

Locking System for Domestic Gas Cylinders

by M.A. Bhatnagar

is approved for the Postgraduate Diploma in

Industrial Design.

Guide:

Shri A.G. Rao

Approval Sheet

Diploma project entitled

Indicating System for Domestic Gas Cylinders

by M.N. Narvankar

is approved for the Postgraduate Diploma in
Industrial Design.

Guide:

R. P. Surkar

Chairman :

R. P. Surkar

Examiners :

R. P. Surkar
M. N. Narvankar

Acknowledgements

I sincerely thank

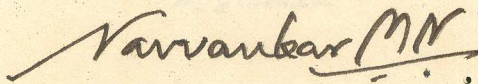
Shri A.G.Rao for his valuable guidance
throughout this project,

Shri Rajan and other workshop staff,

Shri Nagarkar and Shri Patkar,

Shri Radhakrishnan,

and my friends.

A handwritten signature in dark ink, appearing to read 'Narvankar MN'. The signature is fluid and cursive, with the initials 'MN' being particularly prominent and stylized.

(M N Narvankar).

Contents

Chapter	Title	Page
1	Problem Statement	1
2	Introduction	2
3	Information and Analysis	4
4	Hypothesis	11
5	Synthesis	13
6	Design Communications	25
	Appendix	28

1. Problem Statement

To design an indicating device or system for the cooking gas cylinder which will

1. Give an indication (warning) about the quantity of gas left in the cylinder,
2. Check the quantity of gas in the cylinder when supplied.

2. Introduction

Keeping the home fires burning these days is no simple task, specially when the housewife is at the mercy of our cooking gas suppliers. It is hard to fathom how the time taken to deliver a fresh cylinder ranges from a few hours to even a few days. Sometimes the agents are known to tell the customer that they could get their cylinder if they could collect it themselves.

Some consumers complain that their cylinders are underfilled. This can happen if there is connivance between the consumers and the delivery boys. These boys can take a cylinder used by a conniving customer for say 3 days and deliver it to another unsuspecting customer as "full". Meanwhile the conniving customer gets another full cylinder (meant for some one else) for a 'consideration' and this can continue depending on the degree of connivance. (Times of India, dated 30.8.76). Hence there is a need to develop an indicating device, which will

- i. Give indication (warning) about the quantity of gas left in the cylinder
- ii. Check the quantity of gas in the cylinder when supplied.

It is believed that the gas companies have

received several samples of pressure gauges or some other devices to ascertain when the gas is getting over, but none of these are said to be accurate. Certain electronic devices are said to help in this matter but are beyond the reach of average customer.

Hence there is a pressing need to design an accurate and cheap indicating device to ascertain about the quantity of gas in the cylinder.

3. Information and Analysis

3.1 A cooking gas cylinder contains liquified petroleum gas filled at very high pressures.

At present there are two types of gas cylinder supplied in India, namely Burshane and Hindustan petroleum. The tare weights of the

cylinder and the weight of the gas in it are

Burshane (Bharat Refineries) cylinder

Tare weight of the cylinder = 14.400 Kg

Weight of the gas = 14.200 Kg

Total weight of the fresh cylinder = 28.600 Kg

Diameter of the cylinder = 32 cm.

Height of the cylinder = 66 cm.

Hindustan petroleum (Esso) cylinder

Tare weight of the cylinder = 13.8 Kg

Weight of the gas = 12.800 Kg

Total weight of the fresh cylinder = 26.600 Kg.

Diameter of the cylinder = 24 CM

Height of the cylinder = 60 CM

On an average a full cylinder containing 12.800 or 14.200 Kg gas as the case may be, lasts for 25-30 days, for a family of 5-6 people. This gives an average consumption of about 0.5 Kg of gas per day. This implies that the indicating device should be able to measure at least with an accuracy of 0.5 Kg. Also generally the gas cylinders are stored





inside the kitchen under kitchen platform or under a table. In many cases however, they are stored (kept) open, next to platform on the floor either because the platform height is too small or because it is inconvenient to operate.



At present there is no means to check when the gas is getting over. However a few house wives can make out

- (i) by keeping proper count of days
- (ii) by changes in the flame of burner (the flame becomes high when the gas is getting exhausted).



However most of the house wives are at loss and have no means to check this. Gas companies do not allow to keep extra cylinder due to shortage of cylinders. Even if allowed it requires a consumer to keep additional deposit of Rs. 250/-.



3.2 The gas companies have also imposed certain constraints on the indicating devices, namely

3.2.1 No internal devices which will change the basic structure of the gas cylinder would be accepted, since this will involve very high expenditure.

3.2.2 No external devices on the surface of cylinder which will get damaged during transit and multiple handling.

These constraints imply that the indicating device should be completely external and should, in no way tamper with the cylinder.

3.3 Various methods of measuring quantity of gas :

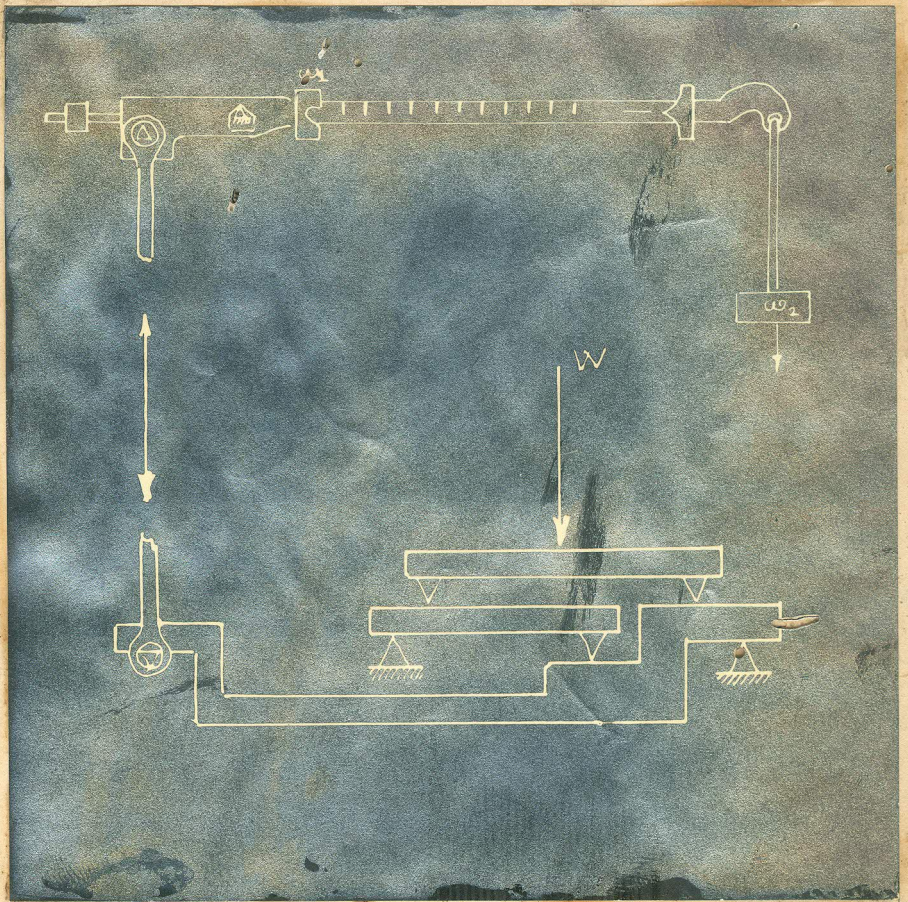
The quantity of gas can be measured in terms of either weight or volume or pressure. In case of cooking gas, as the gas is consumed in the stove more and more quantity of liquid vapourizes, maintaining a steady pressure through out until the last drop of liquid is boiled over. Hence conventional pressure gauges are not useful here.

3.3.1 Weighing type indicators

3.3.1.1 Multiple linkages (levers) platform weighing machines¹ :

In this balances, by means of various links, the leverage obtained is so high that a counter weight of about 0.5 to 1.0 Kg is able to balance a very heavy load of upto 200 Kg or so.

Such a platform scale can be used for weighing the cooking gas cylinder with the gas. However these are too costly and bulky. But since the leverage required in case of cooking gas cylinder will be comparatively



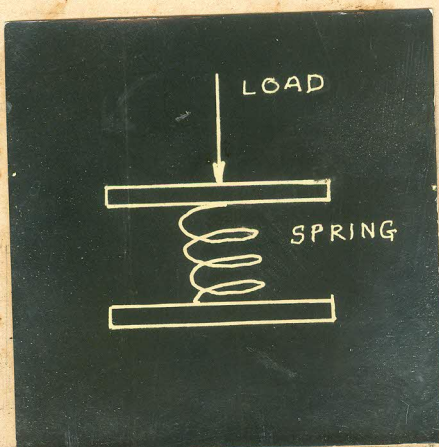
less, using the same principle and with lesser sophistication it is possible to develop a much cheaper weighing machine for cooking gas cylinder.

3.3.1.2 The spring balance :

This makes use of generally compression springs. The deflection of the platform is directly proportional to the load.

Hence by measuring the deflection we can infer the weight.

This principle again could be used for developing a device for weighing cooking-gas cylinder. However the drawbacks with this



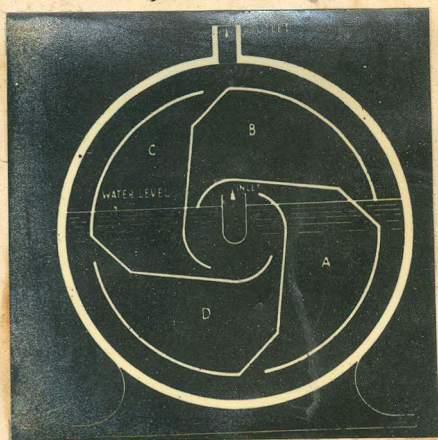
type of devices will be the stiffness of the springs, will vary with usage and the indication won't be correct. Also getting the correct stiffness initially is difficult.

3.3.2 Gas flow meters² (variable volume methods) :

3.3.2.1 Wet type gas meter : This consists of a drum revolving in a cylindrical casting more than half filled with water. The drum is divided into 4 compartments by partitions.

The gas enters the drum at central inlet and the gas pressure makes the drum rotate. The number of revolutions are recorded by a counting mechanism whose readings show the amount of gas consumed. This meter could be used for cooking gas cylinder but for the complications which arise due to evaporation, freezing and maintainance of water level. Also this could be very bulky.

3.3.2.2 Dry gas meter : It comprises of 2 chambers of known volume seperated from each other by leather diaphragm. The pressure of the gas causes the chambers to be alternately filled and emptied, whereky the diaphragm is alternately stretched and relaxed.



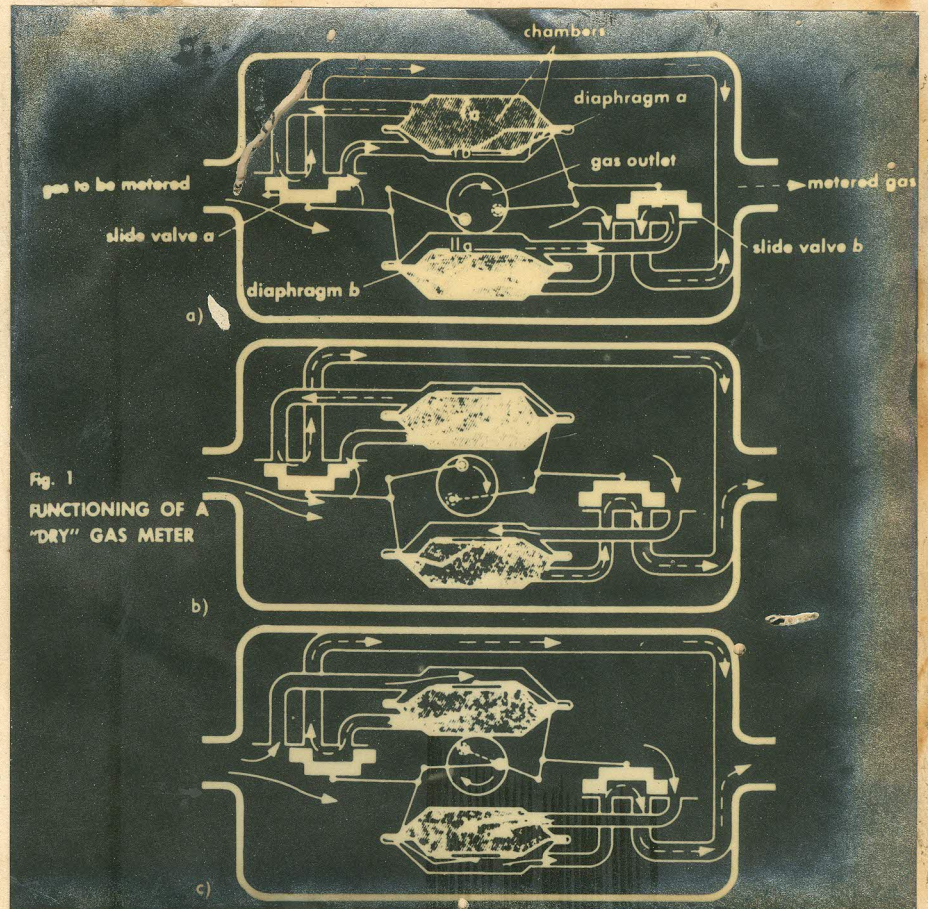
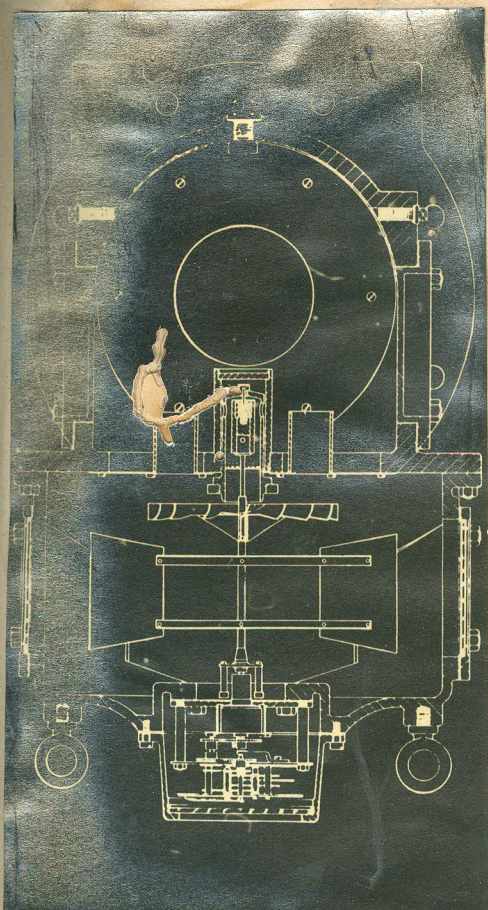


Fig. 1
FUNCTIONING OF A
"DRY" GAS METER

These movements of the diaphragm are transmitted through a lever system to a counting mechanism.

This type of gas meter is very reliable and hence can be used for metering domestic supplies. However this will be very expensive.

3.3.2.3 Shunt gas meter : In this a certain proportion of gas to be measured passes through a bypass circuit where it is directed by nozzles on to the blades of a fan. The number of revolutions of the fan is an indication of the volume of gas passing in



the main. This type of meter is very accurate and can be used for very low flows of gas; however these are very costly meters. Apart from these two groups, certain electronic devices or ultrasonic level indicators etc. could be used conveniently for measuring quantity of cooking gas, but for their exorbitant cost.

Thus from the information and analysis of the various methods available it appears that,

- 1) Gas flow meters type indicators, because of their high cost and the constraints imposed by gas companies can not be used for measuring quantity of cooking gas.
- 2) Conventional pressure gauges are not useful for metering cooking gas which is basically a liquified gas.
- 3) Multiple linkage balances can be used cheaply for measuring quantity of cooking gas, with some modifications.

4 Hypothesis

From the previous chapter, we arrive at following considerations, which the indicator should satisfy, namely :

4.1 It is preferable to design a indicator which indicates the weight of the gas. From the data collected, the average consumption per day is about 0.5 Kg. Hence the device should have sensitivity of atleast 0.5 Kg.

4.2 The indicating device should not be internal and should not tamper with the cylinder.

4.3 Preferably the indicating device should be fully external and a independant unit from the cylinder, which could be permenantly installed in a consumer's house.

4.4 It should be simple and convenient to use and should easily communicate the indication. It is preferable to give either an auditory signal like an alarm or a visual signal like lightening of a red bulb.

4.5 It should be attractive; however since it is placed in kitchen at such a position where it is likely to spill something on it, preferably it should have darker colour.

4.6 Since a heavy cylinder is placed on it,

it should be such that it requires almost no maintainance.

4.7 It should cost reasonably. It should cost in the range of Rs. 50/- to Rs. 120/-.

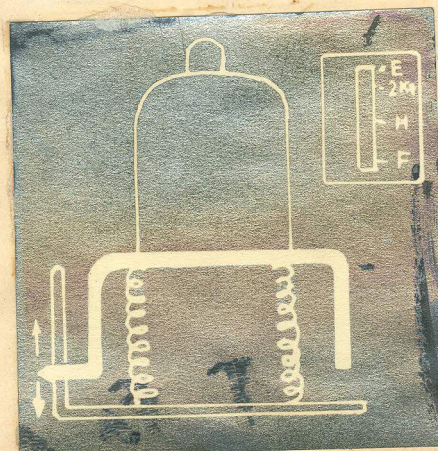
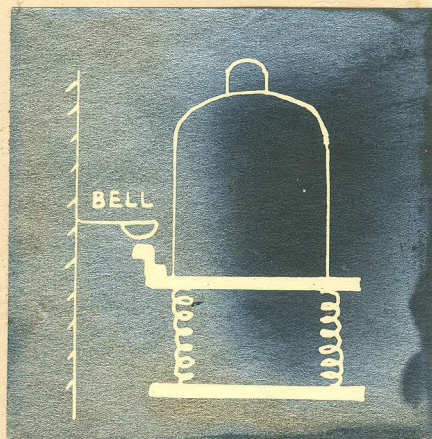
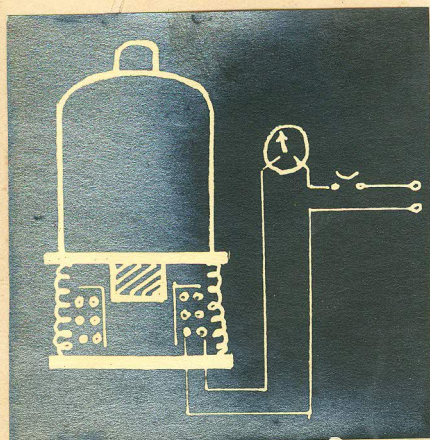
5 Synthesis

5.1 Different Solutions Suggested :

5.1.1 Indicating device based on calibrated springs³ :

As shown in figure the device consists of 2 supporting plates with strong calibrated springs inbetween. A suitably designed coil of wire is mounted on a bottom plate and there is matching iron core fixed under top plate. The coil is connected to mains through a meter and a switch. When switch is put on current flows through the coil its value depending on relative position of core in the coil. When the cylinder is full, the core is fully in, the current drawn is low; when the cylinder is empty, it is fully out and the current drawn is high. Thus the current passing through the meter at any time indicates the amount of gas in the cylinder.

This is very simple and compact device,



however because of the current meter, it is very costly. Another problem is of calibrating of springs which is quite difficult. Also the stiffness of springs varies with usage.

By much simpler modes of indication the cost can be decreased to some extent. Some of the modes are illustrated on the previous page.

5.1.2 Device based on U tube manometer :

This device actually measures the level of liquid gas by measuring the pressure produced by the column of liquid gas. This can be joined to the lower part of gas cylinder or to the overflow tube.

However this device has many drawbacks, namely

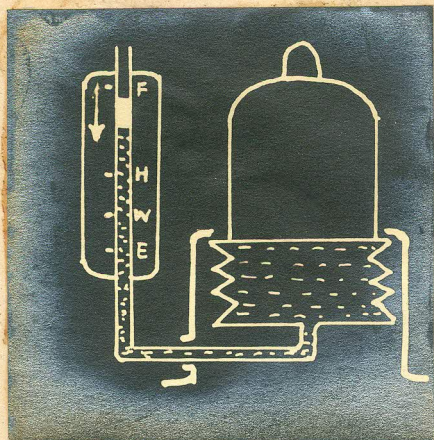
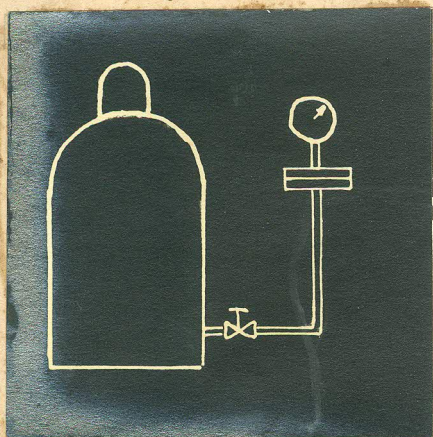
1. It requires special skill and care to set up. Every time a check is to be made, the gas burner will have to be disconnected.
2. It is not safe and wastage of gas may occur.

5.1.3. Indicator based on bellows :

In this device a bellows filled with suitable liquid is connected to a tube in which there is a small float of weight w , which counterbalances the weight of cylinder and gas, W .

By applying Pascals law, we get $\frac{W}{A} = \frac{w}{a}$,

where A = Cross-section area of bellows
and a = Cross-section area of tube.



But $A \propto D^2$, $D =$ Diameter of bellows
 $d =$ Diameter of tube.

$$\therefore \frac{W}{D^2} = \frac{w}{d^2} \quad \therefore \frac{W}{w} = \left(\frac{D}{d}\right)^2,$$

taking $W = 40$ Kg, $w = 0.1$ Kg and $D = 40$ cm.,
 we get $d = 2$ cm, indicating engineering feasibility of the system.

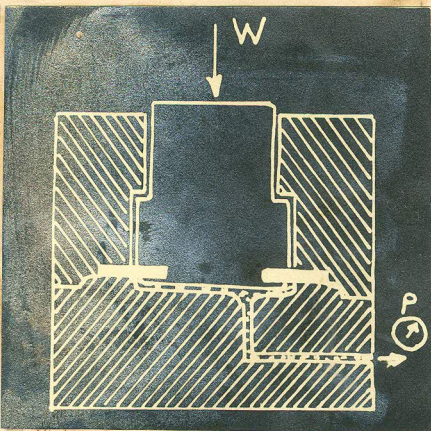
This could be very cheap indicator.

The problem with this device is evaporation of the fluid in tube and bellows and leakages.

5.1.4 Hydraulic load cell⁴:

This device is based on the principle that a force applied to one side of a piston or diaphragm and a pressure hydraulic applied to another side, some particular value of pressure will be necessary to balance the force.

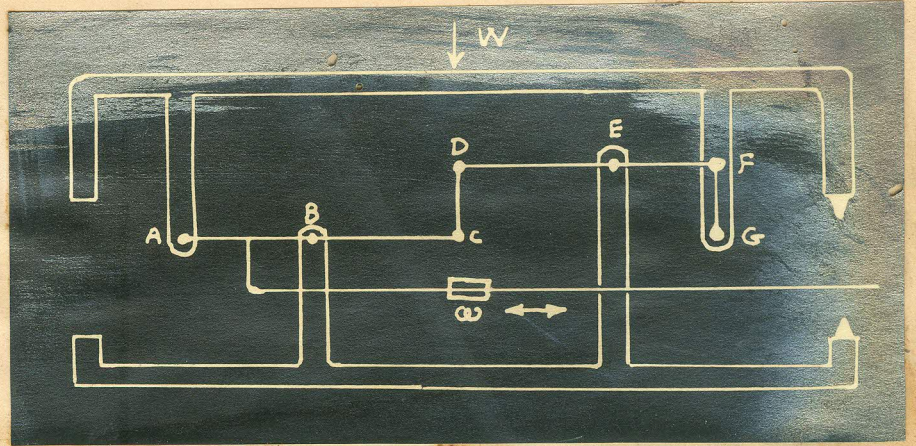
Figure explains the device. Depending on the value of W , resulting oil pressure will change showing different readings on pressure gauge which can be calibrated in terms of weight of gas plus that of cylinder.



This device will be very accurate, however it is sensitive to temperature changes and so provision should be made for zero setting adjustments. Also this would be quite costly.

5.1.5 Indicating system based on multiple linkages⁵ :

The device consists of link mechanism shown



in figure above, where in link $BC = \text{Link } DE$
and link $DC = \text{link } FG$.

The platform has translational motion.

The weight of the cylinder plus gas, W is counterbalanced by a small counter weight w , sliding on a beam. Thus the beam is marked with positions corresponding to w counterbalancing weight of empty cylinder to weight of empty cylinder plus full quantity of gas. Thus the consumer can set the weight w , wherever he wants; as this weight is reached the beam becomes horizontal. At this point either an electric contact can be made and a bulb will light or an alarm can ring giving indication. This is very simple and robust device. It does not require any maintainance, and could be quite cheap.

5.1.6 Provision of reserve section as in automobiles :

The provision of reserve section in the gas cylinder itself will be really most effective solution. This will necessitate some structural

changes in the cylinder like provision of false bottom and a second outlet for the gas. However this will involve heavy capital expenditure. But it could be implemented in the making of new cylinders.

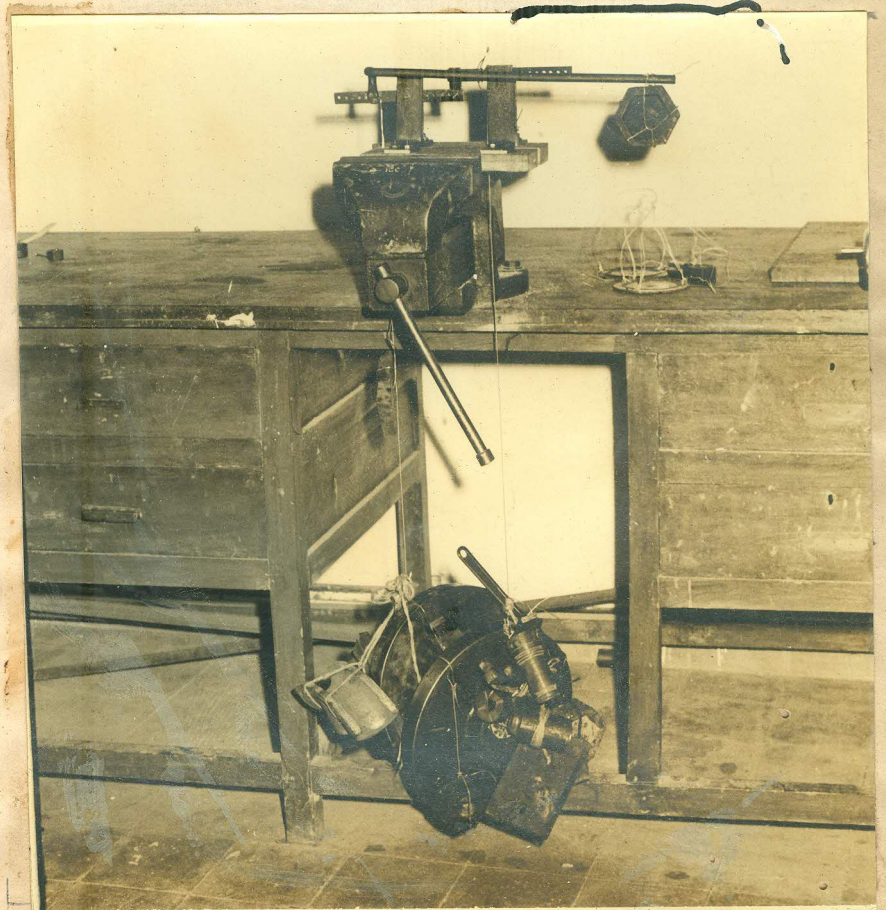
From the various solutions suggested above, the solution based on multiple linkages seems to be more appropriate, since

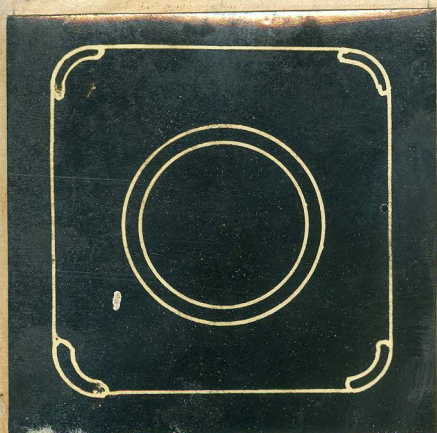
1. It is totally independent and external unit.
2. It could be made quite cheap.
3. It requires almost no maintainance.

Hence it was decided to develop this solution further and design a device ~~based on this~~ concept.

The link mechanism, the lengths of levers and the pivoting points were decided after performing a series of experiments. The photograph below shows the experimental set up, with 40 Kg weight being balanced by a 1 Kg weight.

In the device itself, the load is distributed equally on four points. The proposed design is development of this experimental model.





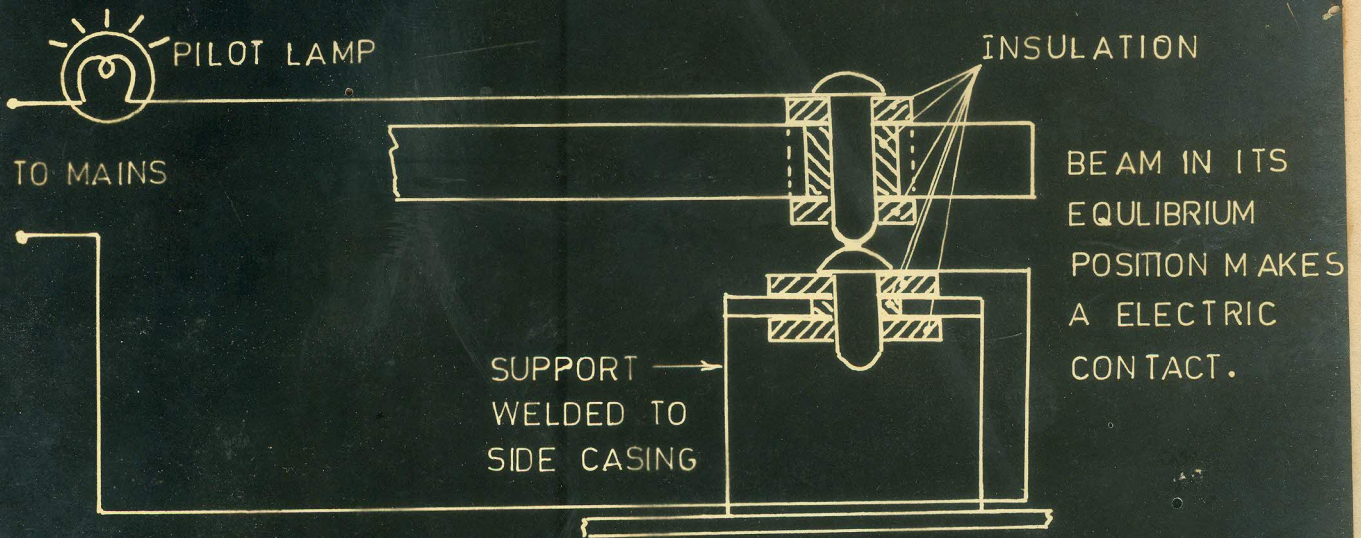
5.2.2 The main features of the proposed device :

5.2.2.1 The platform on which the cylinder is to be placed is so designed that it accommodates both Burshane or Hindustan Petroleum cylinder. Suitable locations are provided which ensure equal distribution of the load and convenient in placing the cylinder.

5.2.2.2 Calibrated scales for both Burshane as well as the Hindustan Petroleum cylinders are provided. Brief instructions are also provided on the front panel.



5.2.2.3 The indication is simple. A pilot bulb connected to the beam, is lighted when beam becomes horizontal (i.e. when the set quantity of gas is reached). The bulb is mounted on the front panel.

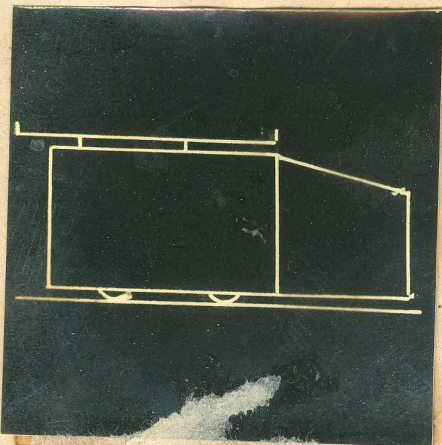


ELECTRICAL CONNECTION

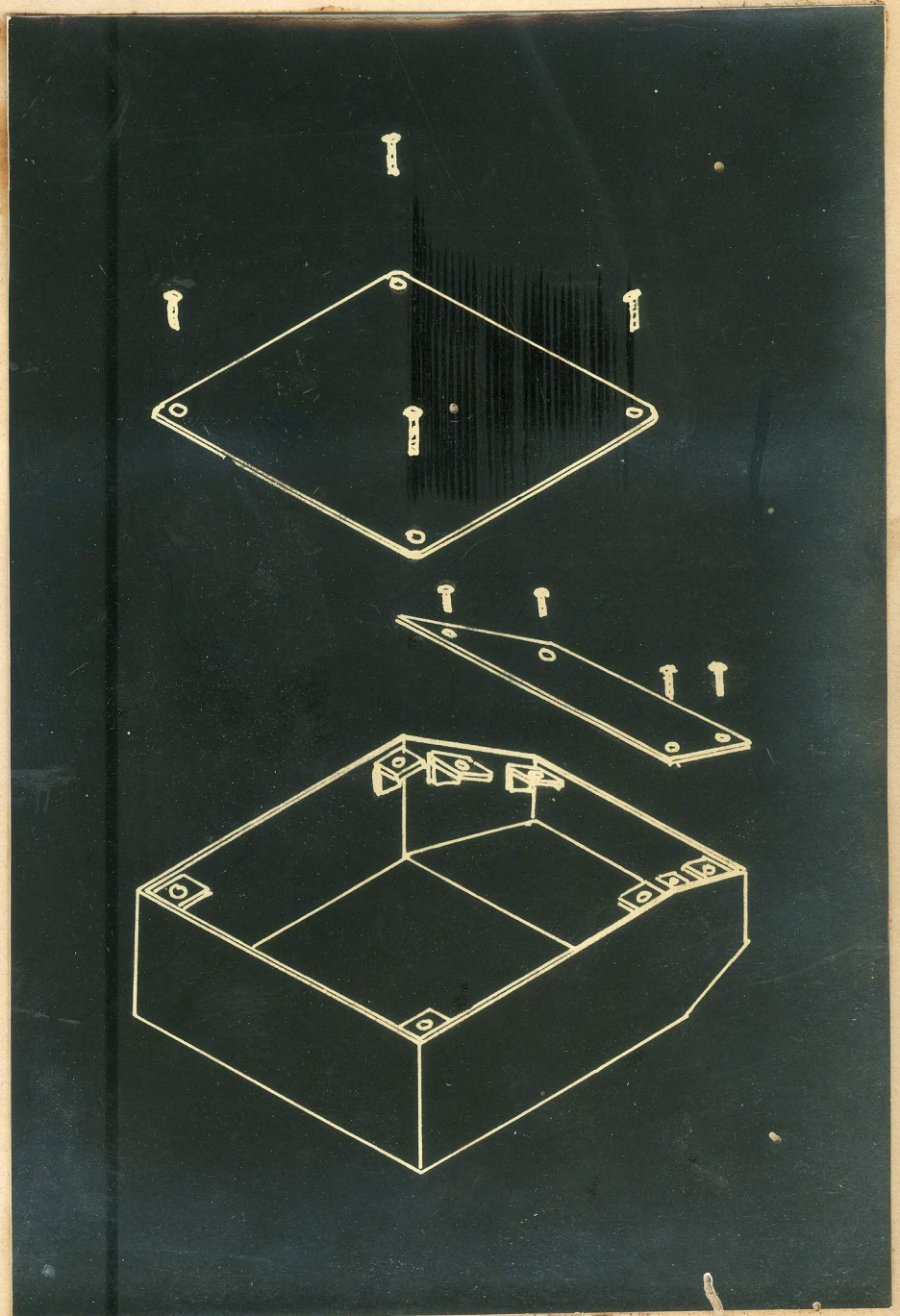
Suitable insulation is provided for the electrical connections. Alternatively an audio signal can be given by fixing an alarm bell below the beam.

5.2.2.4 The device has four wheels. Hence it can be taken out conveniently to place the cylinder and then pushed in under the kitchen platform.

5.2.2.5 The device is very simple and robust. It requires almost no maintenance however the inner link mechanism is accessible for oiling or any other



maintanance, by simply removing the platform and the top covering plate.



5.2.3 Manufacturing Analysis of the Device.

The device consists of following main parts:

5.2.3.1 The platform : This is made from 16 gage sheet metal. The blank can be cut on shearing machine and the locating rings at the centre and locations at four corners can be done on nibbling machine.

5.2.3.2 The casing with top cover are fabricated from 18 gage sheet metal by bending and shearing. The top plate and front panels are screwed.

5.2.3.3 The links are of cast iron and are cast. Alternatively they can be made from bending 3 mm or 4 mm thick strips and welding.

5.2.3.4 The base casting which provides supports for pivoting the links is made from cast iron.

5.2.3.5 The beam on which the slider slides consists of 7 mm diameter mild steel rods.

5.2.3.6 The counter weight is made from lead, it can be either cast or fabricated. It weighs 1 Kg.

The assembly itself is very simple. The

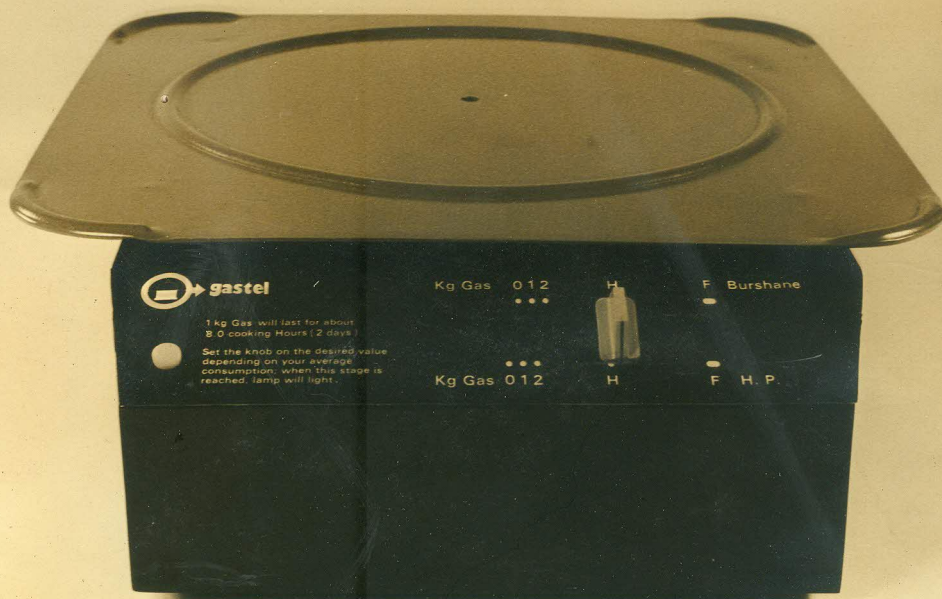
base casting is screwed inside the casing. The links are joined by pins. The wheels are fitted to the side of base casting. The counter weight is fixed on the beam. The top plate is screwed. The platform is rested on the loading points with knife edges which are either cast or fabricated. The whole device may cost approximately around Rs. 100/- to Rs. 120/-.

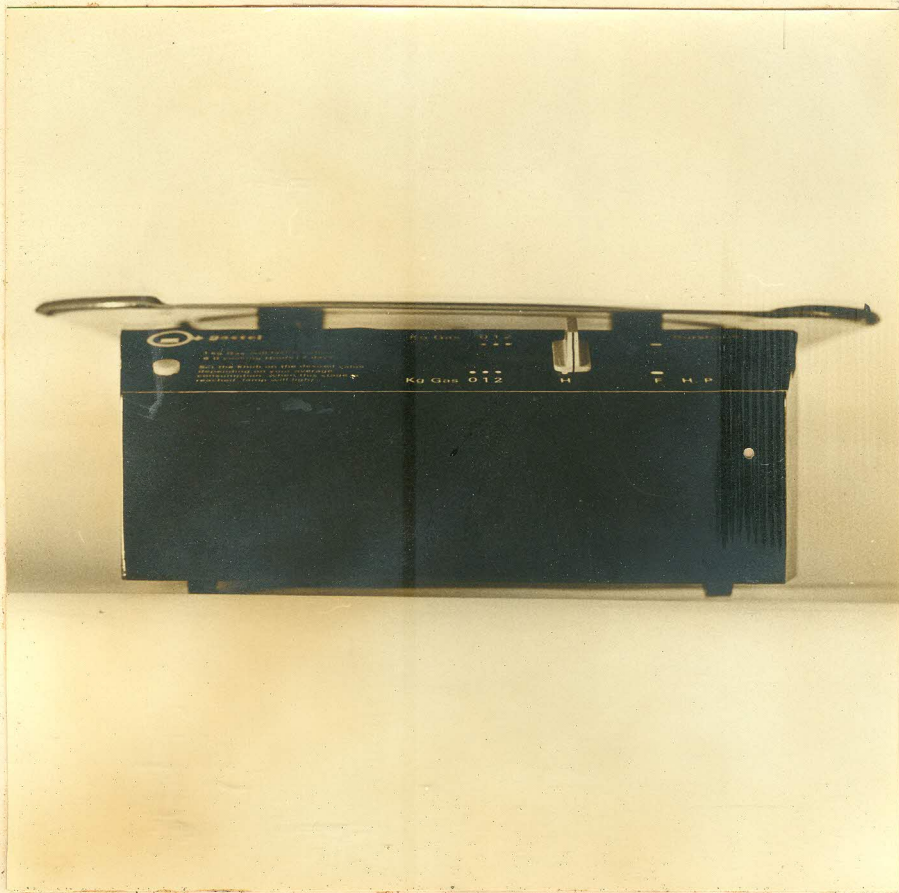
5.2.4 Thus this device will be a general guideline for the house wives to ascertain the quantity of gas left in the cylinder. However, as long as the supply system is not reliable the device would not be very useful. Secondly the house wife can initially check the total weight of the cylinder and can find out wheather the cylinder is underfilled or not.

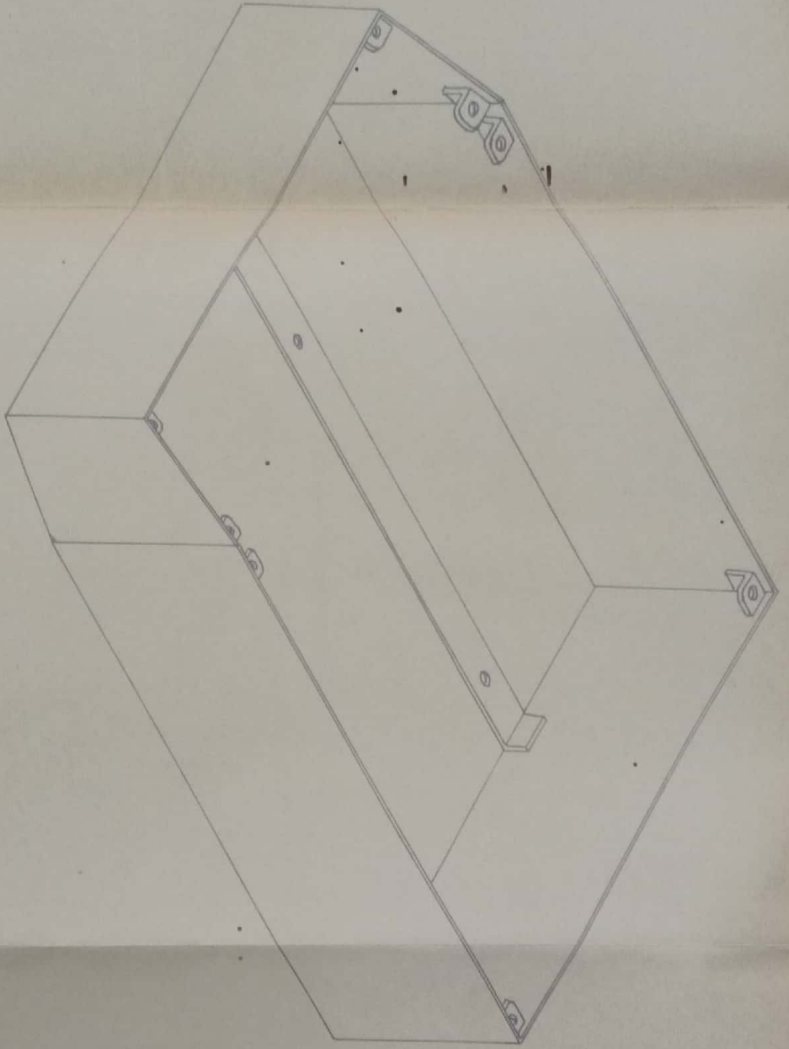
6 Design Communications

6.1 Photographs

6.2 Drawings.







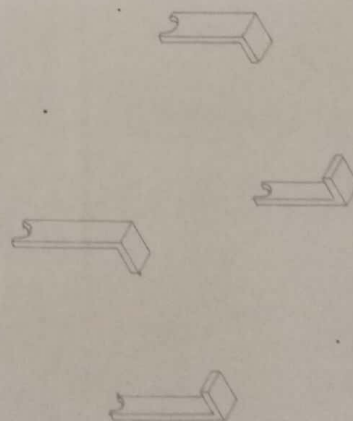
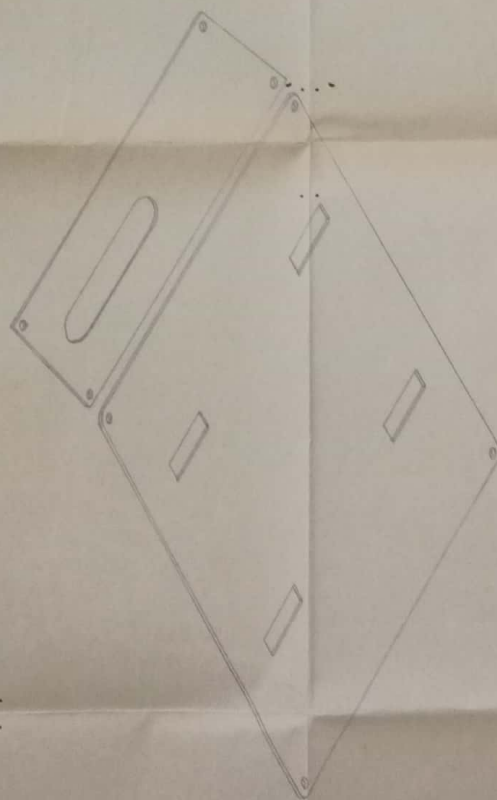
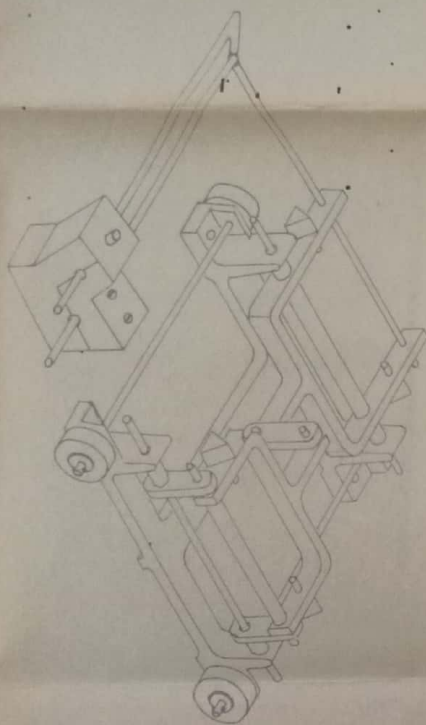
INDICATING SYSTEM FOR DOMESTIC GAS CYLINDERS. EXPLODED VIEW.

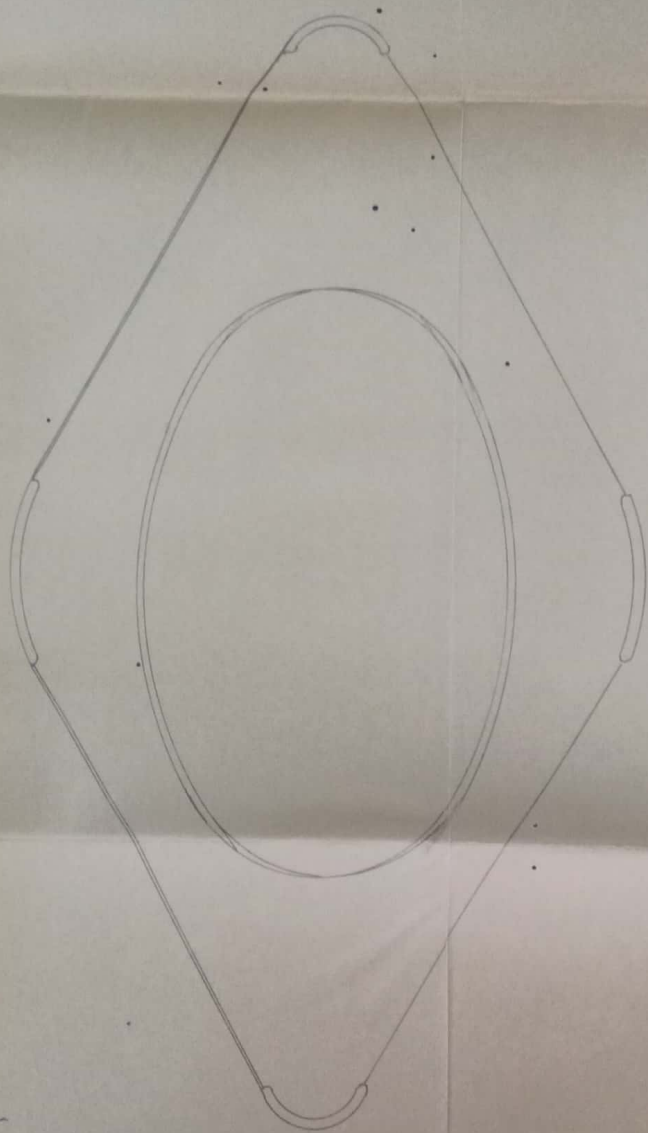
MUNNAPPAIAH.

1970.

SCALE: 1/2.

INDUSTRIAL DESIGN CENTRE, III, BOMBAY.





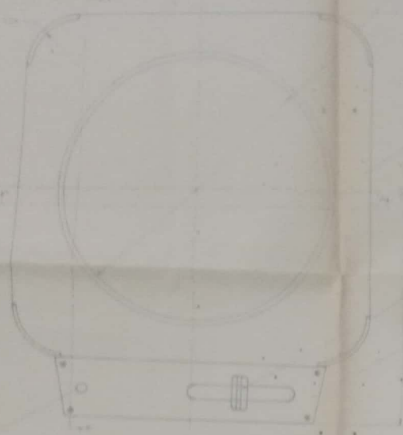


Fig. 1

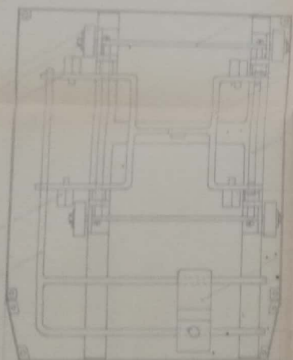


Fig. 2

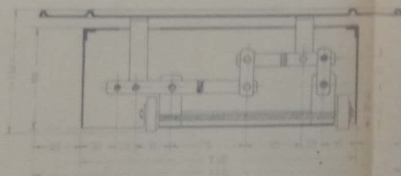


Fig. 3

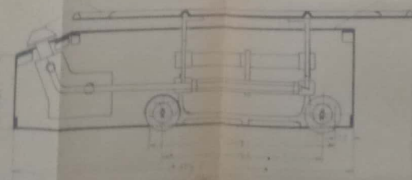
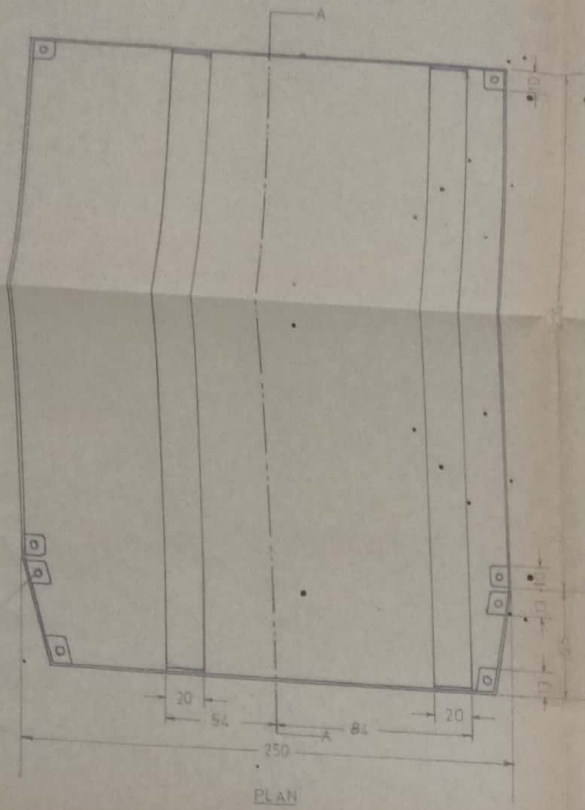


Fig. 4

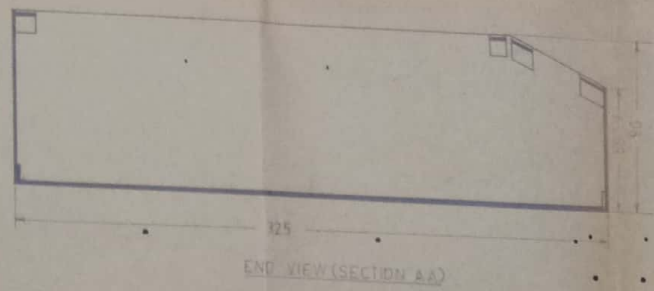
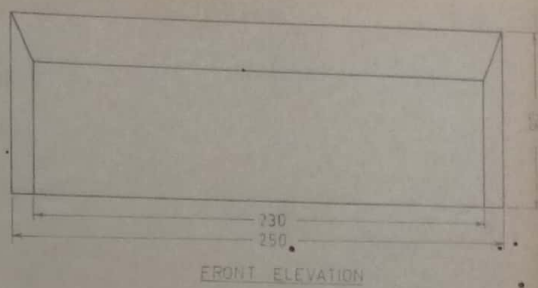
Sl. No.	Part Name	Material	Quantity	Remarks
1	Base Plate	Steel	1	
2	Base Plate	Steel	1	
3	Base Plate	Steel	1	
4	Base Plate	Steel	1	
5	Base Plate	Steel	1	
6	Base Plate	Steel	1	
7	Base Plate	Steel	1	
8	Base Plate	Steel	1	
9	Base Plate	Steel	1	
10	Base Plate	Steel	1	
11	Base Plate	Steel	1	
12	Base Plate	Steel	1	
13	Base Plate	Steel	1	
14	Base Plate	Steel	1	
15	Base Plate	Steel	1	
16	Base Plate	Steel	1	
17	Base Plate	Steel	1	
18	Base Plate	Steel	1	
19	Base Plate	Steel	1	
20	Base Plate	Steel	1	
21	Base Plate	Steel	1	
22	Base Plate	Steel	1	
23	Base Plate	Steel	1	
24	Base Plate	Steel	1	
25	Base Plate	Steel	1	
26	Base Plate	Steel	1	
27	Base Plate	Steel	1	
28	Base Plate	Steel	1	
29	Base Plate	Steel	1	
30	Base Plate	Steel	1	
31	Base Plate	Steel	1	
32	Base Plate	Steel	1	
33	Base Plate	Steel	1	
34	Base Plate	Steel	1	
35	Base Plate	Steel	1	
36	Base Plate	Steel	1	
37	Base Plate	Steel	1	
38	Base Plate	Steel	1	
39	Base Plate	Steel	1	
40	Base Plate	Steel	1	
41	Base Plate	Steel	1	
42	Base Plate	Steel	1	
43	Base Plate	Steel	1	
44	Base Plate	Steel	1	
45	Base Plate	Steel	1	
46	Base Plate	Steel	1	
47	Base Plate	Steel	1	
48	Base Plate	Steel	1	
49	Base Plate	Steel	1	
50	Base Plate	Steel	1	

INDUSTRIAL DESIGN CENTRE, U.T. BOMBAY

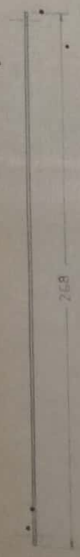
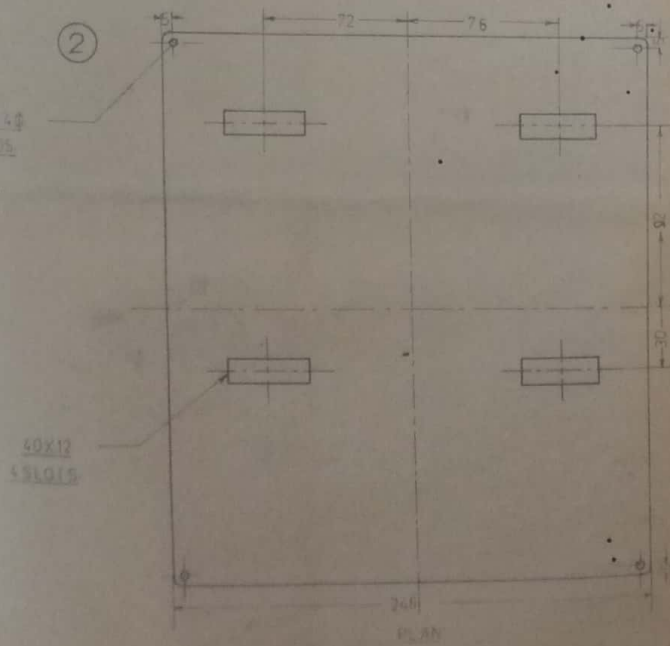
①



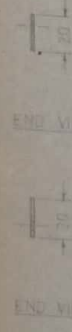
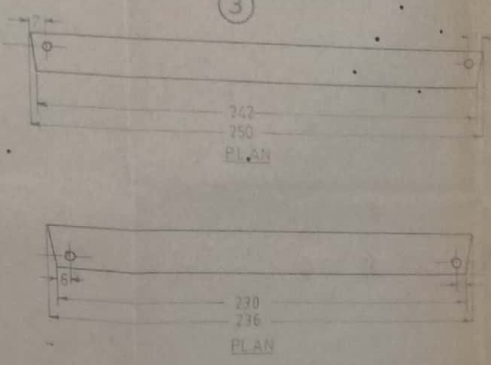
DETAIL AT TOP CORNERS



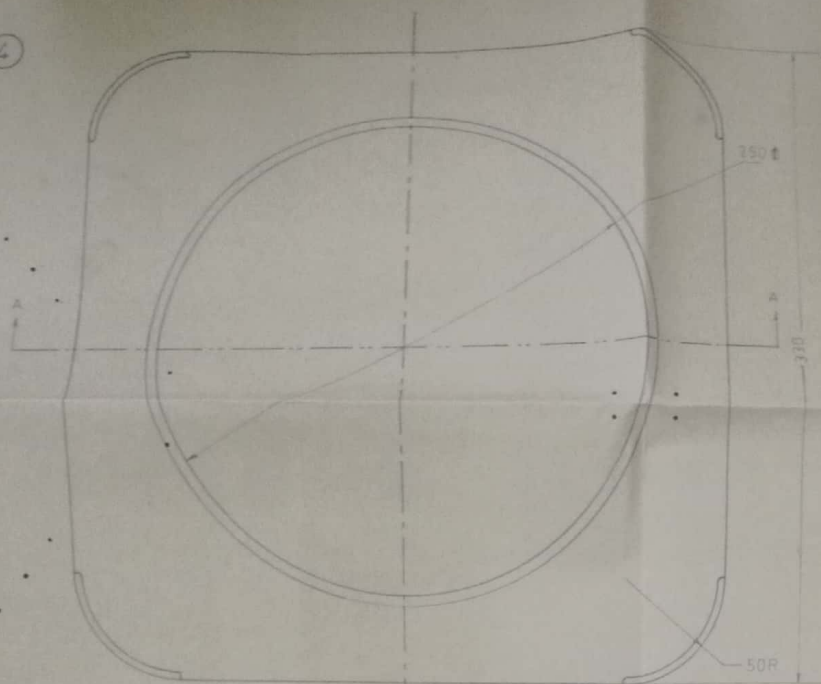
②



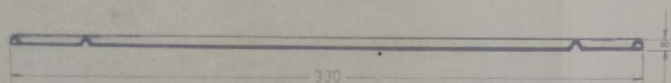
③



④

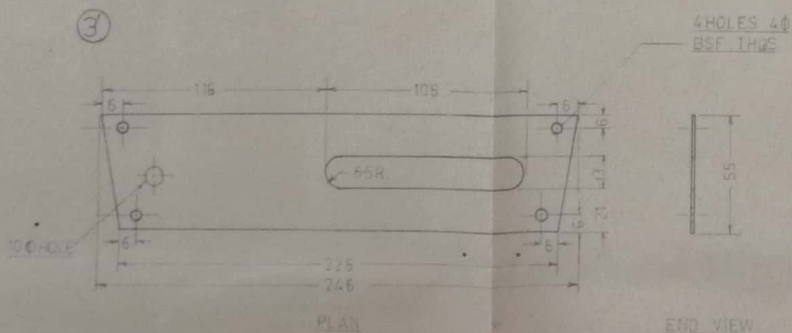


PLAN



FRONT ELEVATION (SECTION AA)

③



PLAN

END VIEW

MODIFIED PART 3

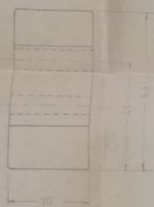
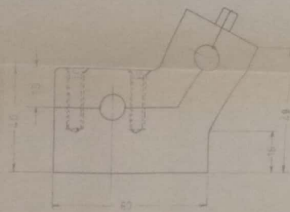
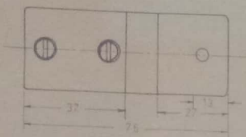
NOTE: PARTS 1 AND 2 SHEET METAL THK. 18 GAUGE.

PART 4 SHEET METAL THK. 16 GAUGE.

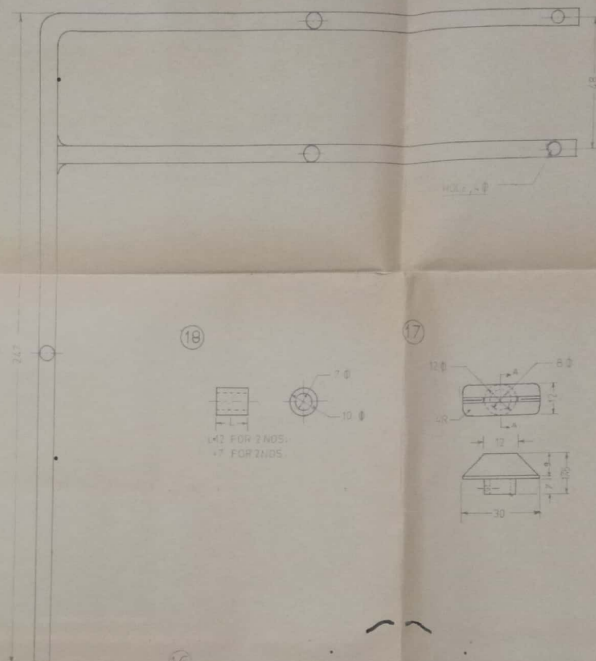
PART 3 TO BE PUNCHED FROM 18 GAUGE THK AL PLATE.

INDICATING SYSTEM FOR DOMESTIC GAS CYLINDERS.		PARTS.
M. NARVANKAR.	752701.	SCALE: 1:2
ALL DIMENSIONS ARE IN MM.		
INDUSTRIAL DESIGN CENTRE, I.I.T. BOMBAY.		

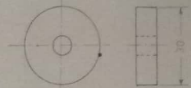
9



13



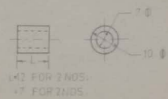
14



15

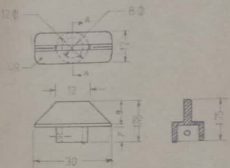


18

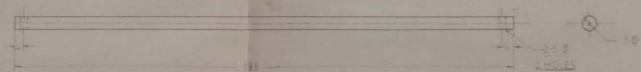


L=2 FOR 3 NOS.
+7 FOR 2 NOS.

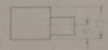
17



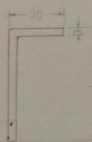
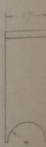
16



11



12



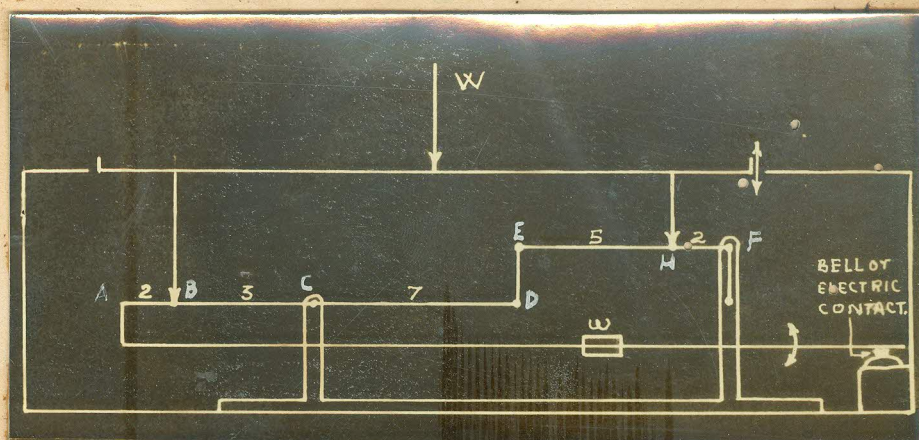
L=65 FOR 2 NOS.
+51

BONDING SYSTEM FOR DOMESTIC GAS CYLINDERS		PARTS
1. BONDING SYSTEM	2. BONDING SYSTEM	SCALE 1:1
3. BONDING SYSTEM	4. BONDING SYSTEM	
INDUSTRIAL DESIGN CENTRE, IIT, BOMBAY		

APPENDIX

Analysis of the link mechanism

The weight W is distributed equally at points B and H respectively.

Link EHF

$$\sum M_F = 0 \quad (+ \text{ gives})$$

$$- \frac{W}{2} \times \frac{2}{1} + R_E \times 7 = 0$$

$$\text{or } R_E = \frac{W}{7}$$

$$\text{Now } R_D = -R_E = -\frac{W}{7}$$

Link ABCD

$$\sum M_C = 0 \quad (+ \text{ gives})$$

$$- \frac{W}{2} \times \frac{3}{1} + R_D \times \frac{7}{1} + w(1-5) + w'(5) = 0$$

$$\text{Now } R_D = -\frac{W}{7},$$

w = weight of counterweight = 1.0 Kg.

$w' = \text{weight of beam} = 200 \text{ gms.} = 0.2 \text{ Kg.}$

$\therefore$ Substituting we get

$$-\frac{W}{2} \times \frac{3}{1} + \left(-\frac{W}{7}\right) \times \frac{7}{1} (+1(1-5) + 0.2(5)) = 0$$

$$\text{or } -0.5W + 1-5 + 1 = 0$$

$$\text{or } 1 = 0.5W + 4$$

Where l is the length at which the counter weight w balances a load of W Kg.

Hence by putting the proper values, for Burshane and H. P. gas cylinders we get, various lengths required as,

Qty. of gas	Empty	1 Kg. gas	2 Kg. gas	Half	Full
Length in cm. for					
Burshane	11.20	11.70	12.20	14.75	18.30
H.P.	10.90	11.40	11.90	14.10	17.30

References

1. T. G. Beckwith, N. Lewis Buck, "Mechanical Measurements", (1973), P 347.
2. H. J. Cooper, " Scientific Instruments", P 142-P 144.
3. Mr. Satyanarayan, "Science Today", March 1975.
4. T. G. Beckwith, N. Lewis Buck, "Mechanical Measurments", (1973), P 362.
- 5-I. I. Artobolevsky, "Mechanisms in Modern Engineering design? Vol 1., P531-P539.