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(57) Abstract :
To design An advanced closed nebutization and spirometry system which allows for nebulization of patien of Covid 19 and also allows spirometry with oxygenated air, without producing any aerosols To prevent or slowdown of progression of the disease from mild to moderate stage or from moderate to severe stage of the disease. To reduce the incidence of spread of the disease from a known patient to other patients and to health car workers by reduction of aerosol production. The Device should be used only for patients who are in requirement of face mask or lesser Oxygen Requirement AC NRBM - for shifting patients on FACE MASK AC FACE MASK - for shifting patients on Nasal prongs or symptomatic patients on Room Air Scomponents are there in the HOAC unit 1. HOAC M: High Oxygenation Aerosol Controlled Mask 2. HOAC MIS: High Oxygenation Aerosol Controlled Motivational Incentive Spirometer 3. NCRB: Non-Collapsing Reservoir Bag 4. Advanced nebulization chamber 5. Specialized oxygen delivery tubing and Protective fabric This unit allows for spirometry and nebulization of a Covid positive or other airborne disease patient without any aerosol generation. This allows for delivery of high flow of oxygen. These components can be used for 5 purposes with connection changes. This leads to it being called as a combo unit 1. High Oxygenation Aerosol Controlled Motivational Incentive Spirometry (HOAC MIS) or High Oxygenation Motivational Incentive Spirometry (HO - MIS) 2. High Oxygenation Aerosol Controlled Nebulization (HOAC N) 3. Aerosol Controlled NRBM Usage (AC NRBM) 4. Aerosol Controlled Face Mask (AC FM) . 5. Usual NIV mask

No. of Pages : 38 No. of Claims : 10

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I CLAIMS IN THE HOAC COMBO DEVICE:

claim- 1) HOAC M: Highly Oxygenated Aerosol Controlled Mask

page no; 7 Fig 1 (a) : Concept Design of the HOAC MASK

page no; 8 Figure 1 (b): The HOAC Mask in concept of Function

page no; 9 Fig 2 HOAC Mask Concept design as seen from patient end

page no;12 *Fig 6: HOAC MASK without inspiratory and expiratory port*

claim 2) INSPIRATORY PORTS page;11 Fig 4: Inspiratory Ports Concept Design

claim 3) Expiratory Unit and Its function

page; 13 Fig 7: Expiratory Unit (Concept Design)

claim 4) HOAC MIS/HO-MIS VOLUMETRIC INCENTIVE SPIROMETRY & ITS FEATURES & DIFFERENCES

page no; 15 Fig 8: HOAC MIS/HO-MIS (concept design)

claim 5) HOAC-MIS

pageno ;17 Fig 8(A): HOAC MIS (concept design)

page no;18 Fig 13 HOAC MIS Overall view (concept design)

page no;26 Fig 17: HOAC MIS in usage (concept design)

claim 6) HO-MIS

page no;19 Fig 8(B): HO MIS (concept design)

page no;27 Fig 18: HO MIS is usage (Concept design)

claim 7) NON-COLLAPSING RESERVOIR BAG

page no;21 **FIG 14(b): NCR Bag (concept design with flow of oxygen during inhalation)**

claim 8) ADVANCED NEBULIZATION CHAMBER AND HOAC NEBULIZATION

page no;22 Fig 15(A) : The advanced Nebulisation unit, with one way valve (concept design)

page no; 23 Fig 15(B):The advanced nebulization chamber attached to the Multifunction port of the HOAC Mask

page no;32 Fig 20: HOAC Nebulisation in use (Concept Design)

claim 9) AC NRBM

page no; 34 Fig 21 AC NRBM in use during shifting of patient usually on Face mask (Concept design)

claim 10) AC Face Mask

page no;35 Fig 22: AC Face Mask usage (for shifting symptomatic patients on Room air or Nasal prongs) (concept design)

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ABSTRACT OF THE INVENTION

HIGHLY OXYGENATED AEROSOL CONTROLLED (HOAC) COMBO DEVICE FOR COVID 19 AND AIRBORNE DISEASES

AIMS and OBJECTIVES:

To design An advanced closed nebulization and spirometry system which allows for nebulization of patients of Covid 19 and also allows spirometry with oxygenated air, without producing any aerosols

To prevent or slowdown of progression of the disease from mild to moderate stage or from moderate to severe stage of the disease.

To reduce the incidence of spread of the disease from a known patient to other patients and to health care workers by reduction of aerosol production.

The Device should be used only for patients who are in requirement of face mask or lesser Oxygen Requirement

AC NRBM - for shifting patients on FACE MASK
AC FACE MASK - for shifting patients on Nasal prongs or symptomatic patients on Room Air

5components are there in the HOAC unit

1. HOAC M: High Oxygenation Aerosol Controlled Mask
2. HOAC MIS: High Oxygenation Aerosol Controlled Motivational Incentive Spirometer
3. NCRB: Non-Collapsing Reservoir Bag
4. Advanced nebulization chamber
5. Specialized oxygen delivery tubing and Protective fabric

This unit allows for spirometry and nebulization of a Covid positive or other airborne disease patient without any aerosol generation. This allows for delivery of high flow of oxygen. These components can be used for 5 purposes with connection changes. This leads to it being called as a combo unit

1. High Oxygenation Aerosol Controlled Motivational Incentive Spirometry (HOAC MIS) or High Oxygenation Motivational Incentive Spirometry (HO - MIS)
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4. Aerosol Controlled Face Mask (AC FM)
5. Usual NIV mask

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[AROKIARAJ. U]
12/03/2021

DESCRIPTION

HIGHLY OXYGENATED AEROSOL CONTROLLED (HOAC) COMBO DEVICE FOR COVID 19 AND AIRBORNE DISEASES

INTRODUCTION

Respiratory diseases are one of the most common diseases all around the world. They are a major cause of mortality in the developing world especially in children and elderly people. Every year millions are affected by respiratory symptoms which can vary from mild disease to severe varieties. (1)

Various causative organisms have been indicated in the development of these diseases. Viruses, bacteria, fungal organisms have been involved in this disease.

Among the therapies for these respiratory diseases, one important method is to deliver the active drug onto the involved system directly. This would require fewer doses of the drug and the response will be better. Inhaler therapy and Nebulization are two such procedures where the drugs are delivered directly to the respiratory mucosa in particulate matter. Both these procedures are very commonly used procedures by pulmonologists and respiratory therapists. The patients with ARDS can be administered with inhaled steroids and Bronchodilators by nebulization which help in early recovery (2)

Nebulization entails using a nebulizer machine connected by tubing to a nebulizer mask which is fixed to the patient. The machine initiates the procedure and the conduit and mask help in delivering the drug to the respiratory system of the patient. Some amount of drug is delivered to the patient, but some part of the drug gets dissipated away from the openings in the mask before reaching the patient's respiratory system. Nebulization also helps to moisten the respiratory mucosa thus helping in the early recovery of the mucosal ciliary activity which then leads to better removal of pathogens from the respiratory system. Thus, it helps in bronchodilation and reduce the inflammation of lung parenchyma

Another therapy that pulmonary specialists depend on is the use of Incentive Spirometry. This procedure requires the patient to breathe in (or out) forcefully from a spirometer so that any mucus and secretions can be coughed out easily and effectively. Recruitment of alveoli takes place and that leads to better oxygenation and removal of carbon dioxide from the body. Spirometry also helps in the reduction of the incidence of complications of respiratory infections like pleural effusion etc.

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Both these procedures make a major part in the armamentarium of the pulmonologists and all other specialties who are dealing with patients with respiratory disease.

These two procedures have a significant role in control of the progression of the disease from mild to moderate and from moderate to severe.

But both these procedures have some disadvantages. These disadvantages as explained below are the driving force for our innovation. Patients with highly infectious diseases and deadly diseases are not subjected for these procedures for the fear of spread to the neighboring patients in the surrounding and also to health care workers

The last month of 2019 saw the rise of the deadly Corona Virus which spread very rapidly involving the disability and death of many people all around the world. This disease is more severe in elderly people. Being a respiratory disease, the main physicians involved were the pulmonologists. Many patients are being put on oxygen delivery by nasal prongs, oxygen masks, Non-Rebreathing masks etc. along with NIV and Invasive ventilation. But these patients are not advised for nebulization due to the fear of production of infected aerosols which can spread to the other patients and also to the treating health care workers.

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JUSTIFICATION FOR THE STUDY:

Nebulization is considered an Aerosol Generation procedure (3), (4), (5). At present during the process of shifting a symptomatic patient between wards and hospitals, face masks and NRBMs are used. The patient coughs and sneezes during these shifts. The bioaerosols generated during cough and sneezing have the potential to infect the people surrounding the patient like health care workers and attendants etc. Our device aspires to counter this problem by decreasing the aerosol production by at least 70-80 percent. This helps for a risk-free administration of the therapy and shift.

The Spirometers which are used nowadays can only be used for people with low or no oxygen requirement. The patients requiring high Oxygen supply due to their lung pathology cannot do spirometry as they may get hypoxic during the interruption (6). Our modified Spirometer aspires to address this problem by allowing high oxygen supply during the spirometry procedure. Thus, it can be performed by sick patients also.

We aspire to innovate and bring a modified device which can help reduce the transmission of dangerous pathogens from the patients to the healthcare workers and at the same time also enable even sicker patients to undergo these procedures, which we feel will enable to slow down the conversion of mild disease to moderate and moderate disease into severe disease.

The Device should be used only for patients who are in requirement of face mask or lesser Oxygen Requirement

AC NRBM - for shifting patients on FACE MASK
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Components of the HOAC Device:

PART 1) HIGHLY OXYGENATED AEROSOL CONTROLLED MASK

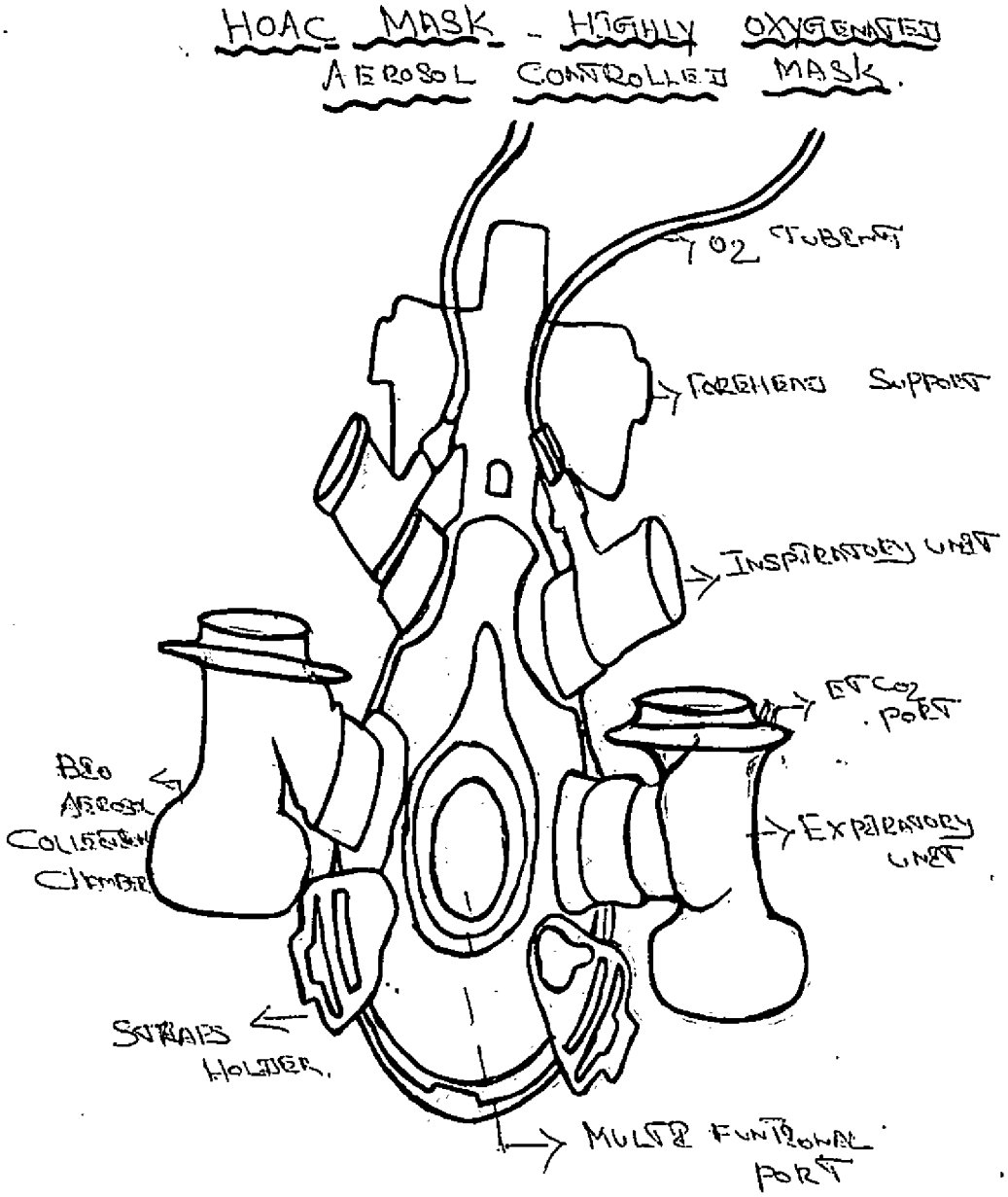

Fig 1 (a) : Concept Design of the HOAC MASK

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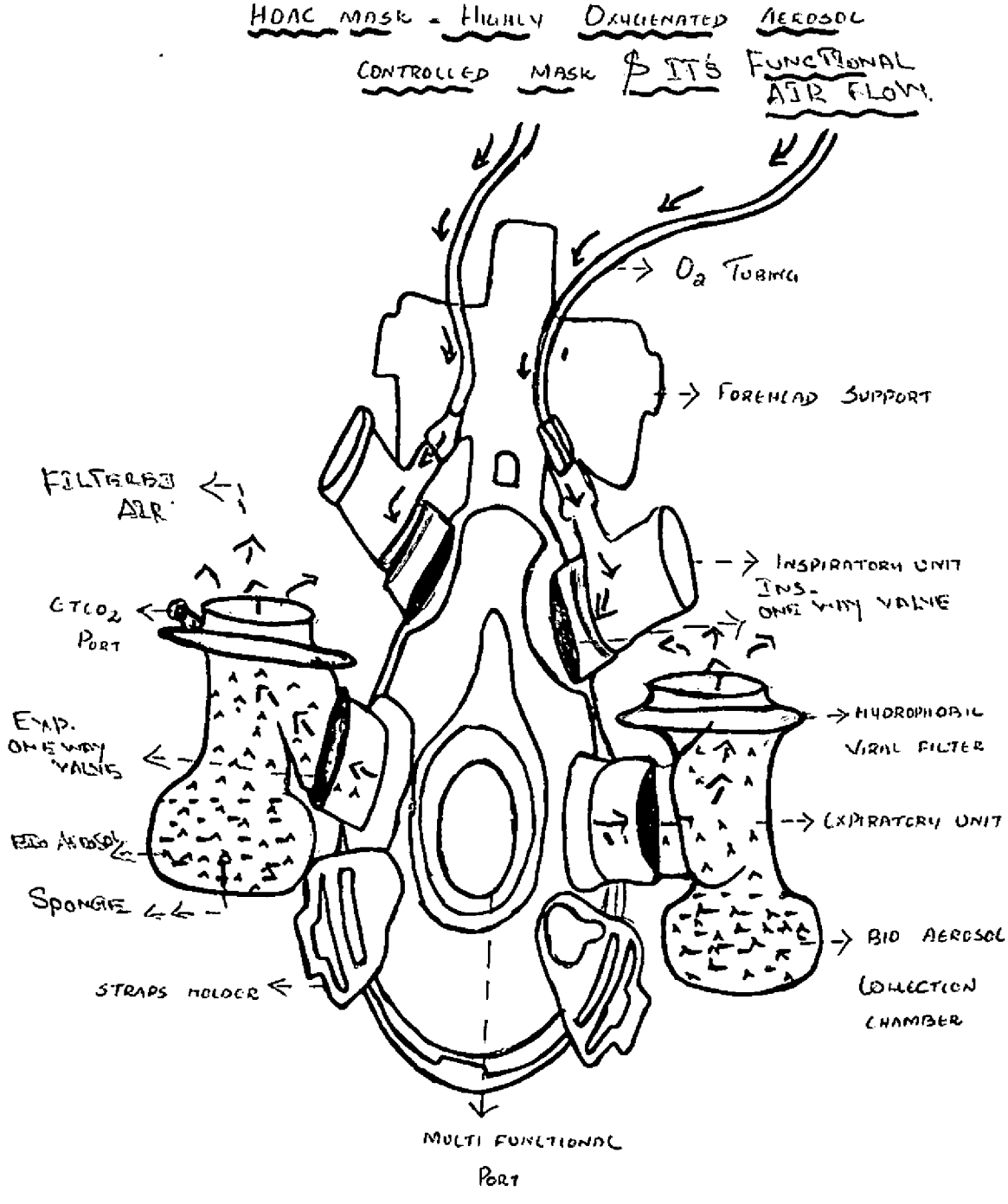

Figure 1 (b): The HOAC Mask in concept of Function

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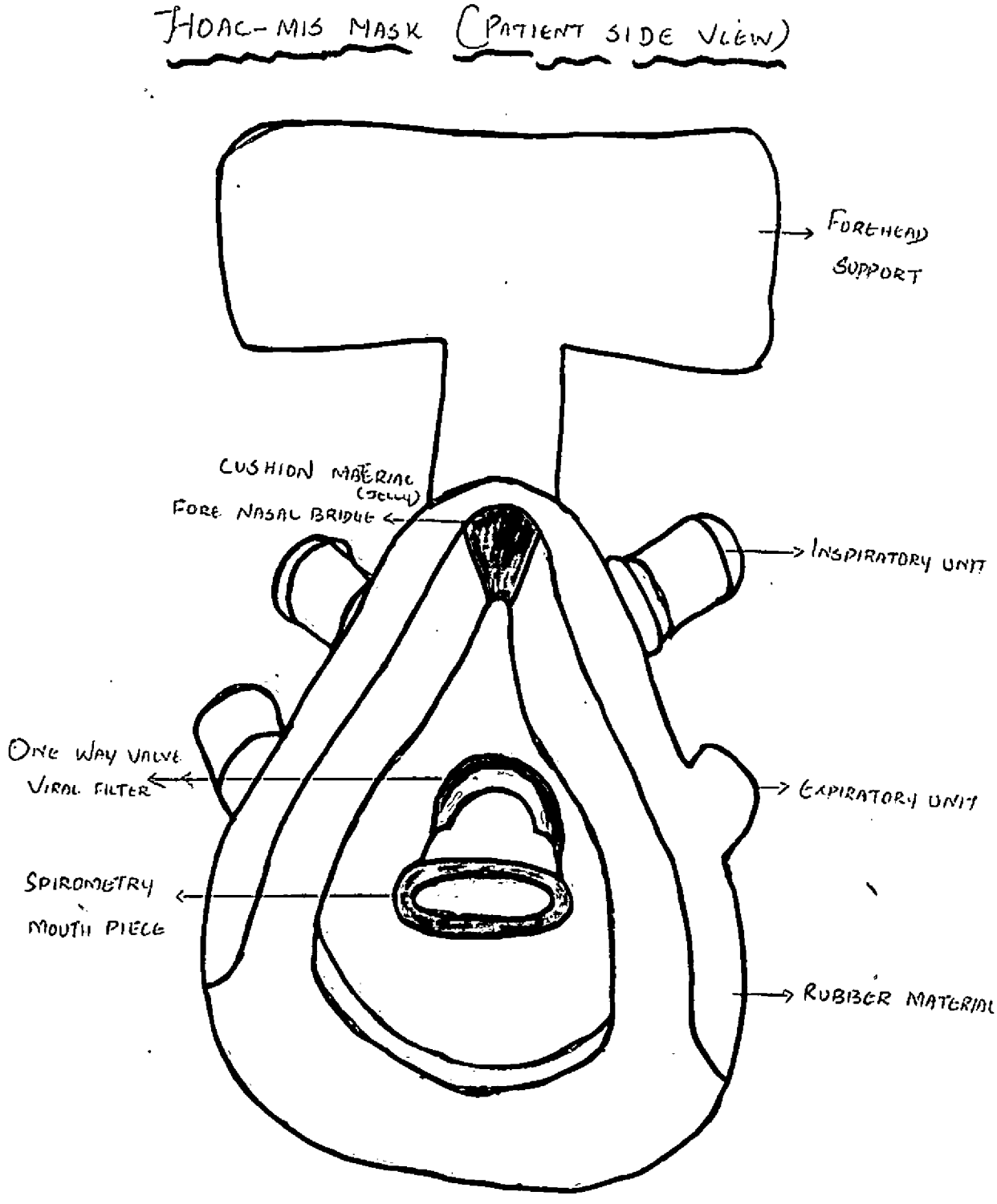

Fig 2 HOAC Mask Concept design as seen from patient end

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DESCRIPTION OF HOAC MASK DESIGN

The mask is similar to a normal NIV mask manufactured according to the size of patient's face- small, medium, large. It has a silicone Gel material at the nose bridge area for prevention of Pressure Sores on the nose bridge. It is connected to an oxygen supply and after connection, is fully sealed to the face of patient with the help of adjustable straps. The mask is having 5 ports in it, each having its own distinguished function:

A) Inspiratory Ports – 2 in number

B) Multifunctional Port – 1 in number

C) Expiratory Ports – 2 in number

INSPIRATORY PORTS: The inspiratory ports are alongside the nose of the patient bilaterally and detachable inspiratory units are fitted in these ports. These units help in delivering the oxygen from the flowmeter to the mask during inspiration according to the patient's demand. The inner side of the unit has a viral filter and one-way valve which opens only on inspiration to deliver filtered highly concentrated oxygen and closes on expiration. The outer portion of the unit is in contact with the atmosphere through a dust filter, diverting the oxygen flow towards the atmosphere when the patient is expiring. In case the oxygen delivery fails, the unit can deliver filtered atmospheric air for inspiration.

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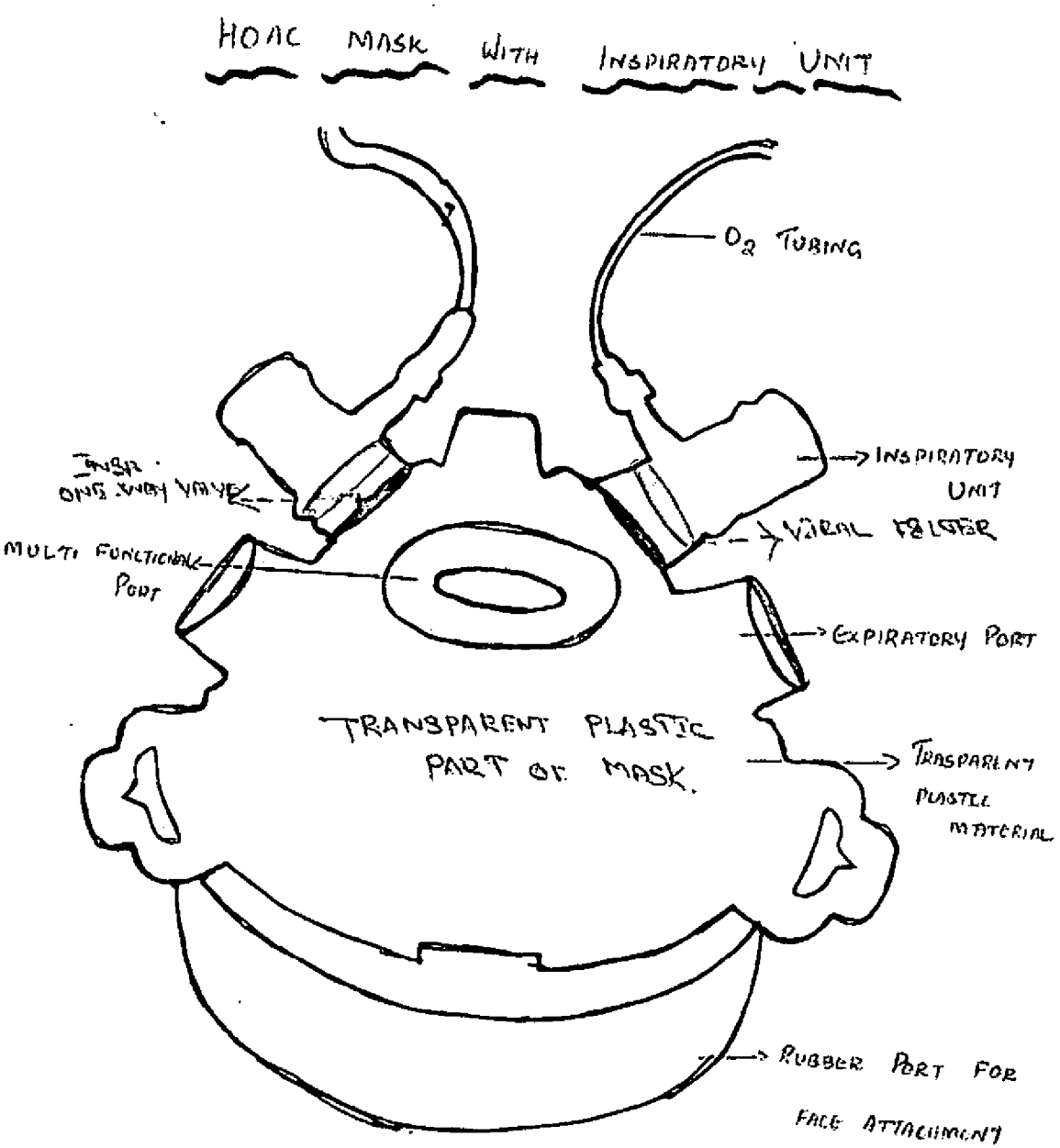

Fig 3 : Inspiratory Ports in position in the HOAC MASK

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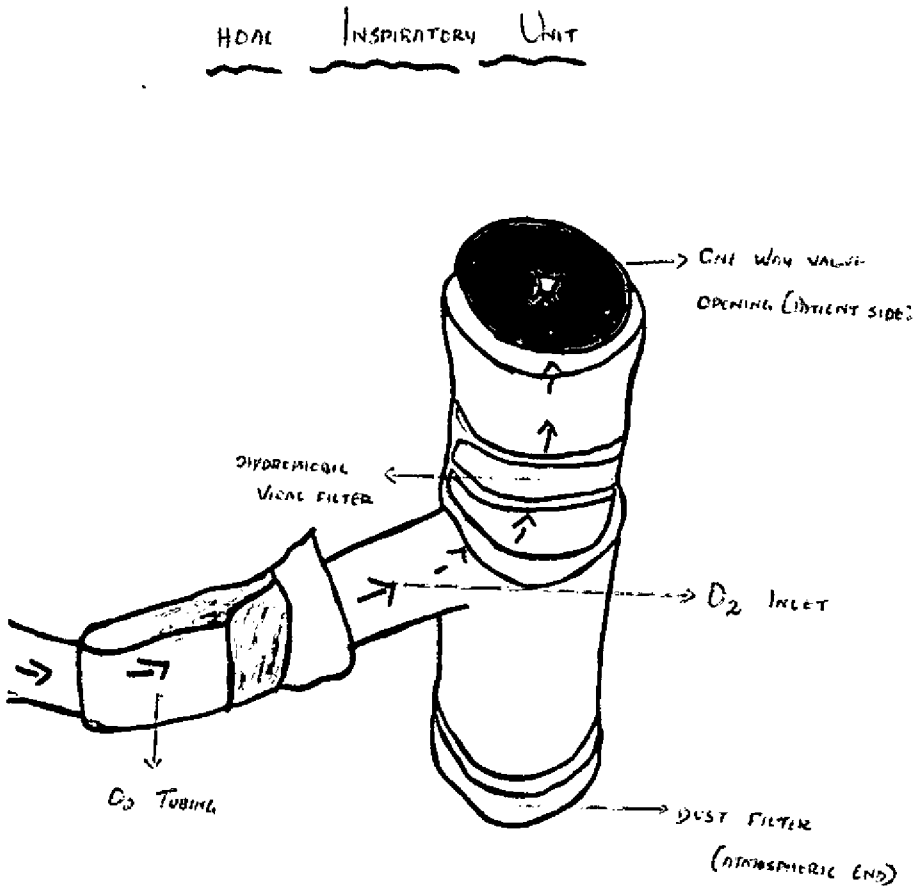

Fig 4: Inspiratory Ports Concept Design

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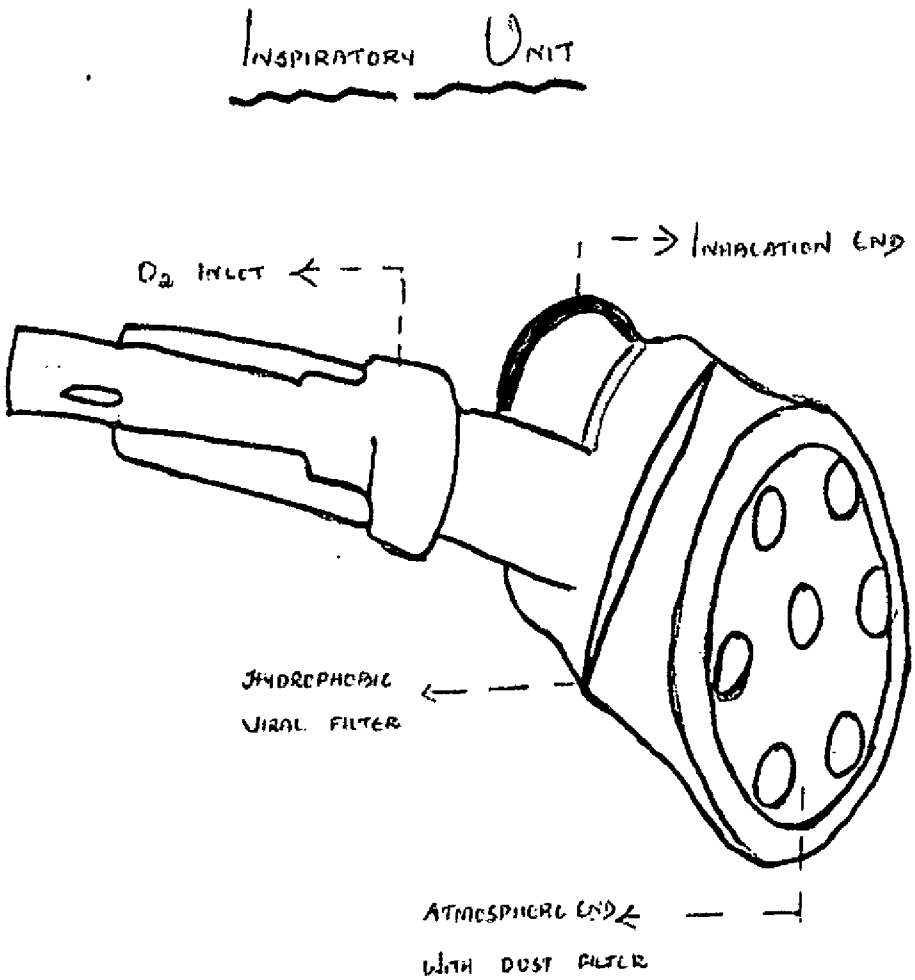

Fig 5 : Inspiratory Port Concept Design (Atmospheric End)

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A. MULTI-FUNCTIONAL PORT: The multi-functional port in HOAC Mask has the possibility to get attached spirometer's mouthpiece (during Spirometry), Nebulisation inlet (during nebulisation), NCRB (when being used as NRBM), Oxygen inlet (usage as Face Mask), and Ventilator tubing (using as NIV). This port is attached to the respective end with an intervening viral filter in all cases except during nebulisation.

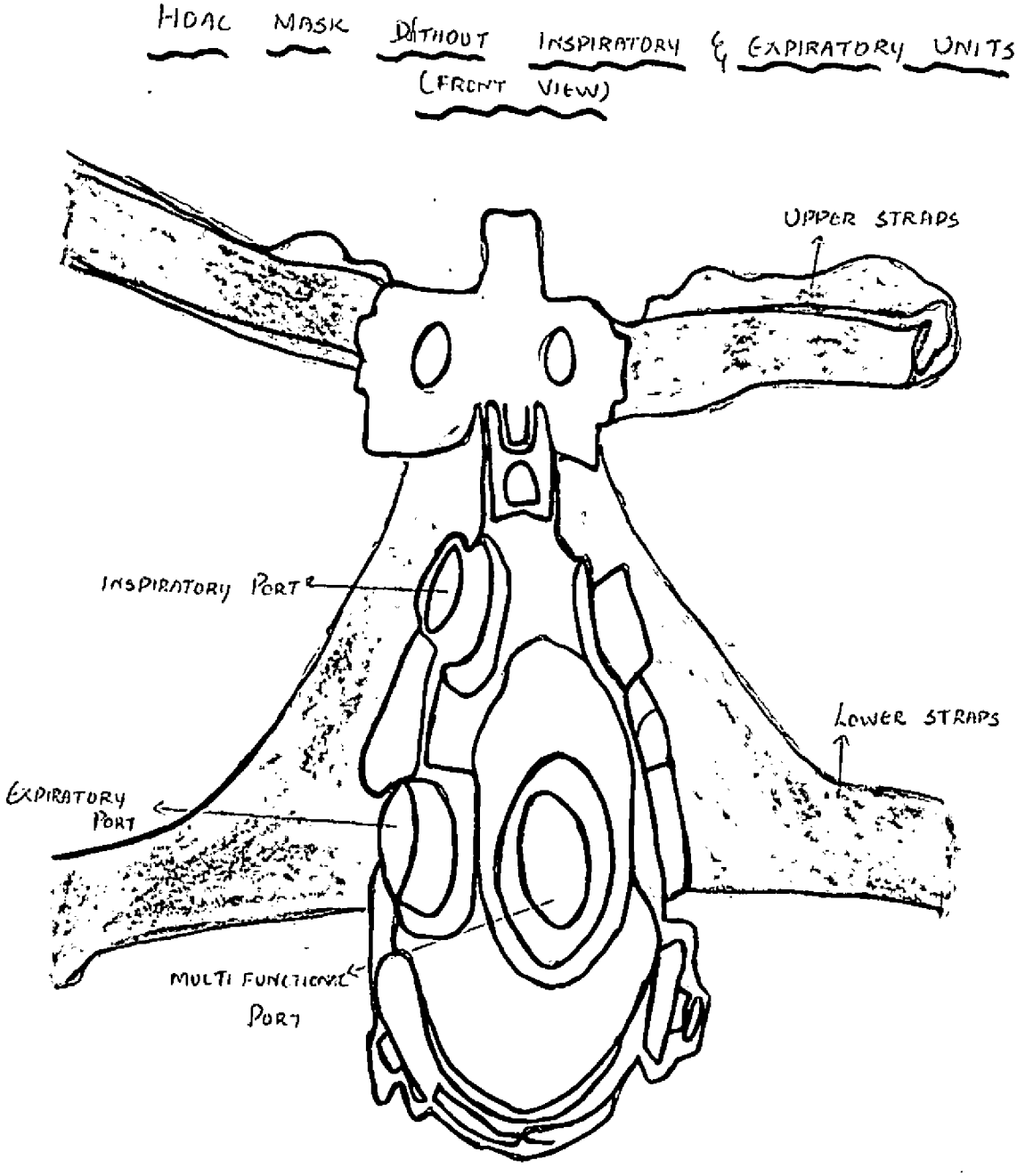

Fig 6: Multifunctional Port (concept Design)

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B. EXPIRATORY PORTS: The expiratory ports lie on the lower part of the mask and are designed for expiration. They are attached with special expiratory units as explained.

a. One-way valve: they are present at the exit point of the Expiratory ports, which allow passage of air only during expiration.

b. The bio-aerosol absorbing chamber: The chamber is made up of transparent plastic material containing an absorbent material like sponge which collects the exhaled liquid by help of condensation and gravity. This part points downwards

c. The filtering chamber: The top part of this special unit has hydrophobic filters.

d. ETCO2 Port: Above the filter there is a port to sample the expired air to assess the ETCO2 The expiratory units should be changed in case of filling up of bio-aerosol absorbing chamber.

HOAC MASK has a protective cap is there to cover the patient end of the HOAC Mask to safeguard for next usage

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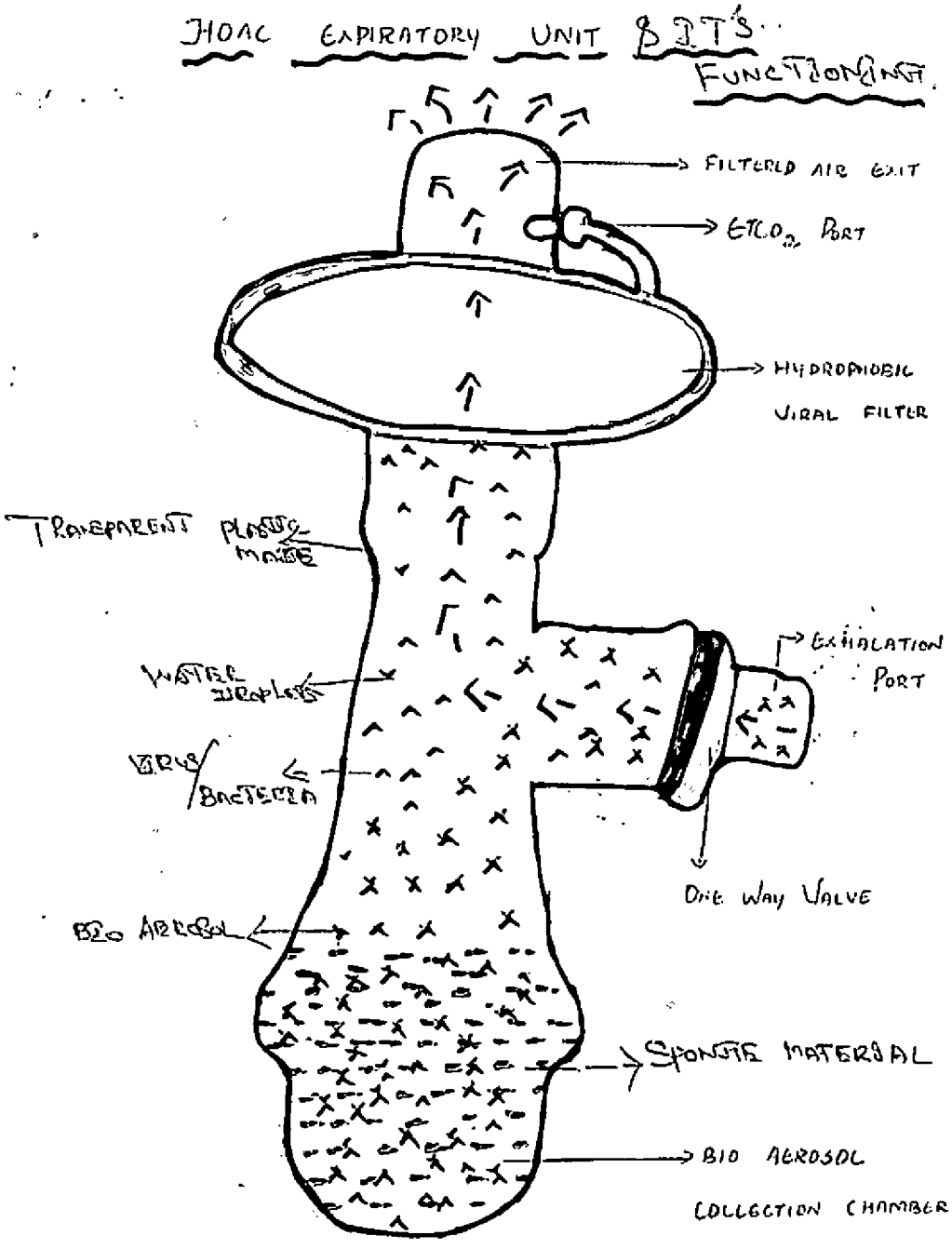

Fig 7: Expiratory Unit (Concept Design)

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PART 2) HIGHLY OXYGENATED AEROSOL CONTROLLED MOTIVATIONAL INCENTIVE SPIROMETER

THIS IS LIKE A NORMAL SPIROMETER WITH SOME CHANGES AS FOLLOWS:

The atmospheric end is connected to non-collapsible reservoir bag. The patient mouth piece tube has one-way valve and viral filter. all the other ports are closed.
This helps in following manner:

1. It will provide filtered highly concentrated oxygen from the reservoir connected to it.
2. It can be used as a completely closed system with no atmospheric interaction or as an open system.
3. The measuring barrel is larger in size and thus makes accurate readings.
4. The pointer on the measuring barrel can be adjusted based on patient's lung condition.

SPIROMETER SETTINGS CRITERIA

It based on patient weight and lung condition:
Here we follow the inhalation spirometer set volume.
Example:
If the patient weight is 50kg than it would be
5x50x2=500ml which has to be held for some seconds at initial days.

Next day 0.5ml/kg/inspiration x2 has to be increased up to 1000ml per inspiration

Once reaching the maximum limit of 1000ml the time (in seconds) will be increased.

This device includes different color codlings based on volume.
The very low volume (0 to 200ml) is black code.
The low volume (200 to 400ml) is red code.
The average volume (400 to 800 ml) is yellow code.
The good volume (800 to 1000ml) is green code.

It indirectly shows the patient's condition.

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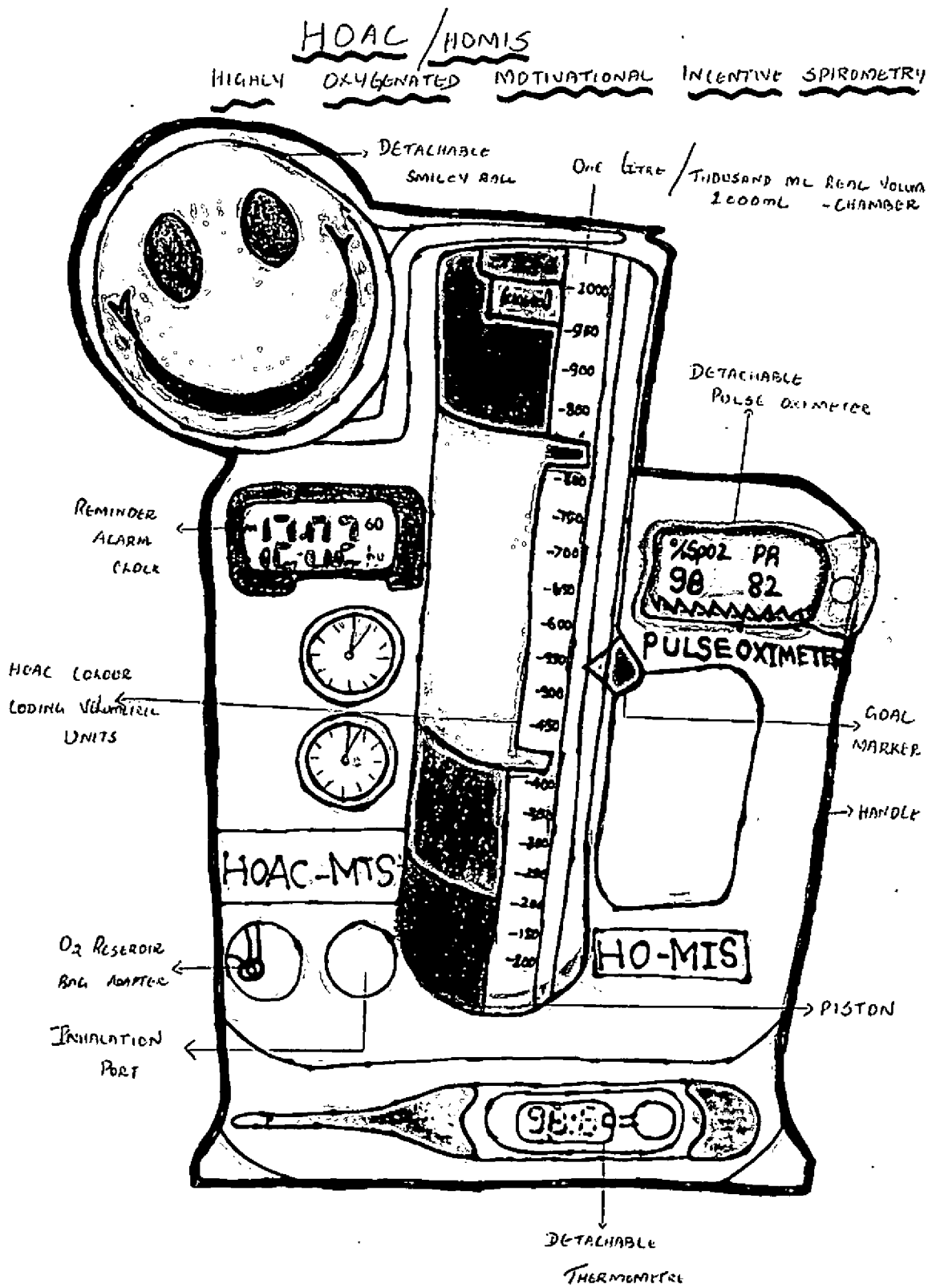

Fig 8: HOAC MIS (concept design)

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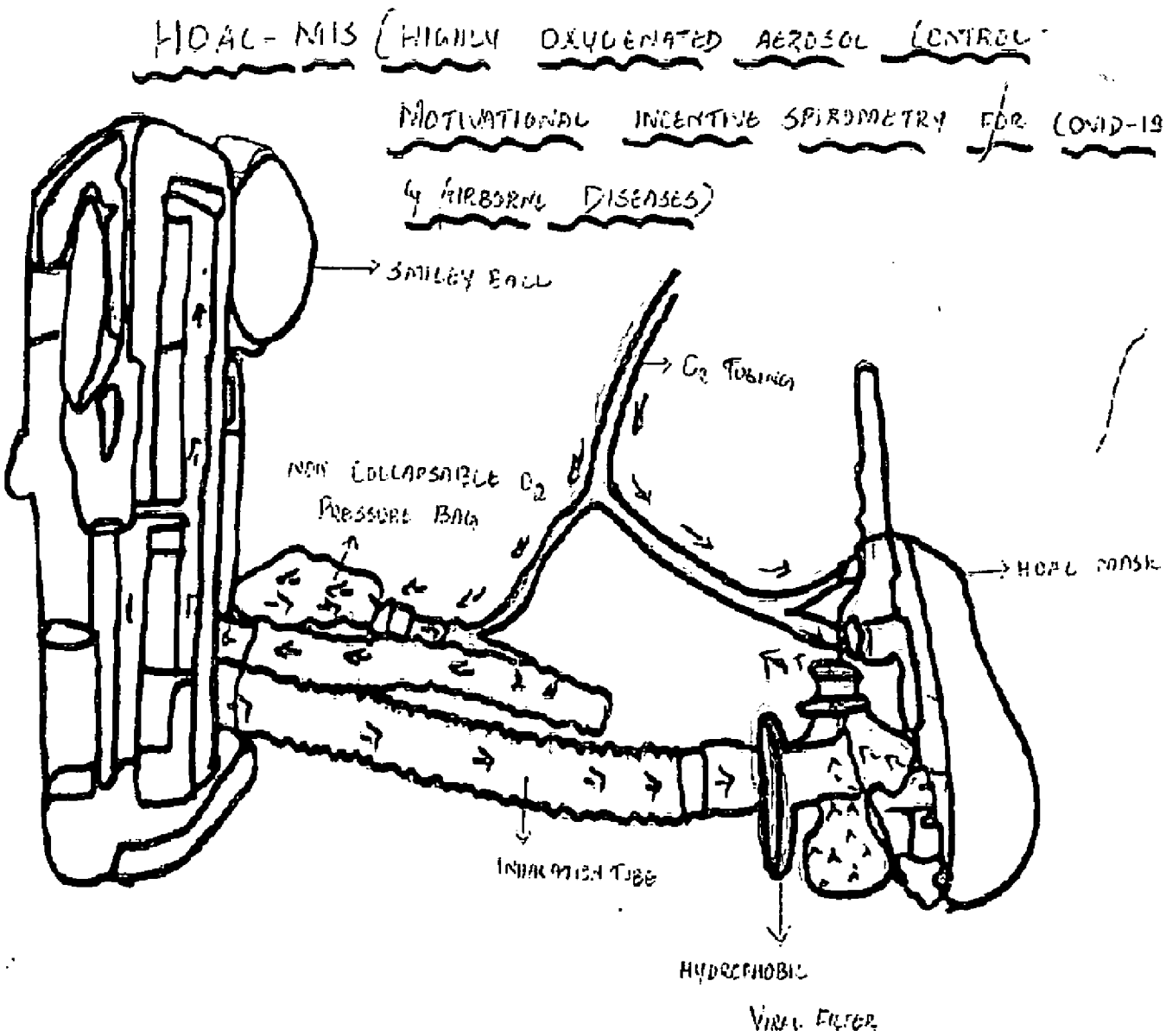

Fig 8(A): HOAC MIS (concept design in use)

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TABLE FOR HOAC-MIS & HOMIS CLOSED SYSTEM SPIROMETER GOAL SETUP FOR LUNG DISEASE (5 to 8 ml/kg x 2/IHS IN COVID 19 AND OTHER AIR BORNE DISEASES

DAY Ml/kg x2/inspiratory hold in Seconds(IHS)	DAY1	DAY 2	DAY3	DAY4	DAY5	DAY6	DAY7
	5ml/kg/IHS	5.5ml/kg/IHS	6ml/kg/IHS	6.5ml/kg/IHS	7ml/kg/IHS	7.5ml/kg/IHS	8ml/kg/IHS
Weight 40kg	400ml	440ml	480ml	520ml	560ml	600ml	640ml
Weight 45kg	450ml	495ml	540ml	585ml	630ml	675ml	720ml
Weight 50kg	500ml	550ml	600ml	650ml	700ml	750ml	800ml
Weight 55kg	550ml	605ml	660ml	715ml	770ml	825ml	880ml
Weight 60kg	600kg	660ml	720ml	780ml	840ml	900ml	960ml
Weight 65kg	650ml	715ml	780ml	845ml	910ml	975ml	1000/+HIS
Weight 70kg	700ml	770ml	840ml	910ml	980ml	1000/+IHS	1000/+HIS

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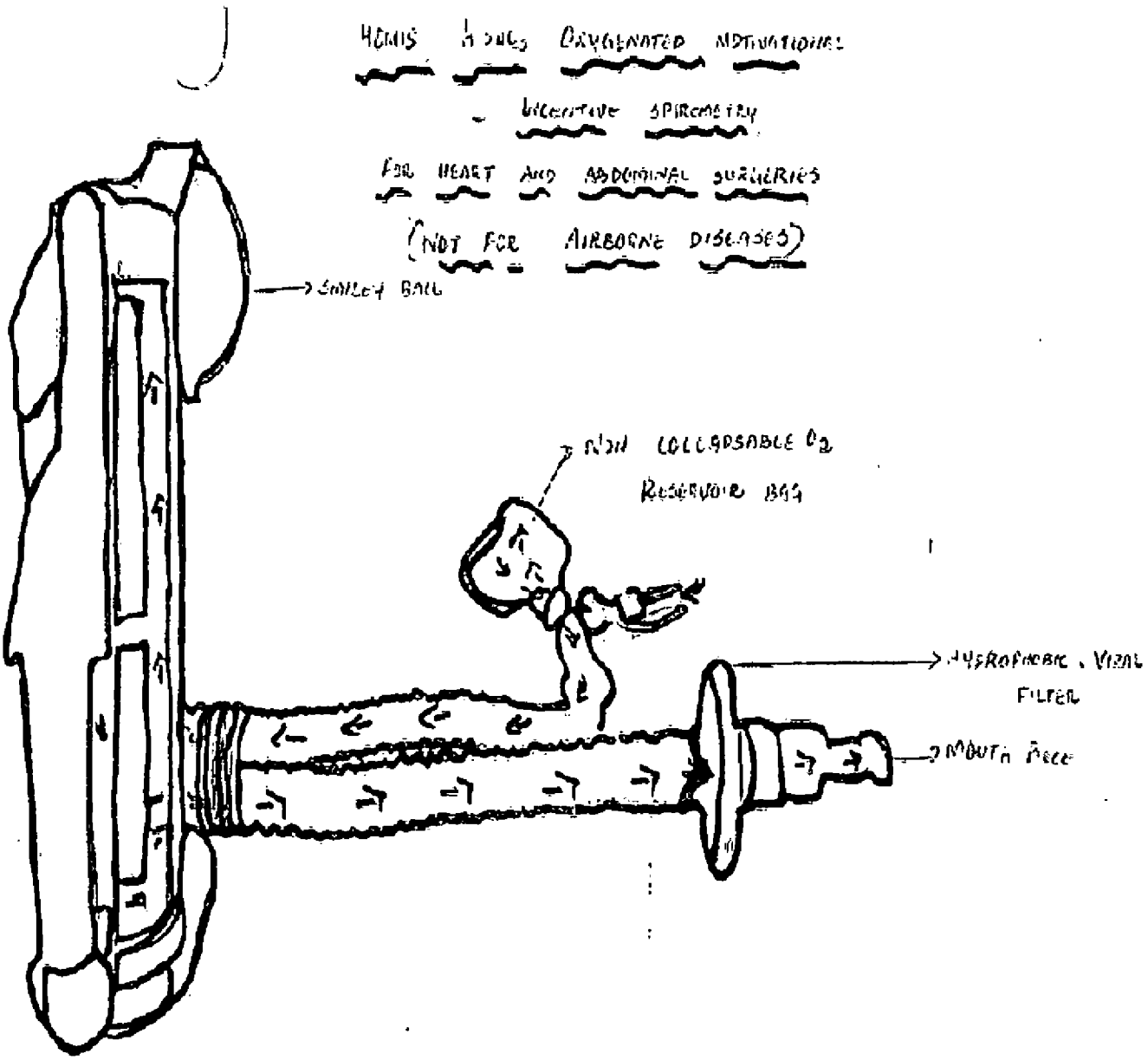

Fig 8(B): HO MIS (concept design)

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TABLE FOR HOMIS OPEN SYSTEM SPIROMETERY GOAL SETUP FOR (7 to 10 ml/kg x 2/IHS IN HEART , ABDOMEN AND OTHER PRE AND POST OPERATIVE SURGERY PATIENTS)

DAY Ml/kg*3/Inspiratory hold in Seconds(IHS)	DAY1	DAY 2	DAY3	DAY4	DAY5	DAY6	DAY7
	7ml/kg/IHS	7.5ml/kg/IHS	8ml/kg/IHS	8.5ml/kg/IHS	9ml/kg/IHS	9.5ml/kg/IHS	10ml/kg/IHS
Weight 40kg	840ml	900ml	960ml	1020ml	1080ml	1140ml	1200ml
Weight 45kg	945ml	1012ml	1080ml	1150ml	1215ml	1280ml	1350ml
Weight 50kg	1050ml	1125ml	1200ml	1275ml	1350ml	1425ml	1500ml
Weight 55kg	1155ml	1230ml	1320ml	1400ml	1485ml	1560ml	1650ml
Weight 60kg	1260kg	1350ml	1440ml	1530ml	1620ml	1710ml	1800ml
Weight 65kg	910ml	1460ml	1560ml	1650ml	1755ml	1850ml	1950ML
Weight 70kg	1470ml	1575ml	1680ml	1785ml	1890ml	1995ml	2000/+IHS

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PULSE OXIMETER AND HEART RATE MONITORING:

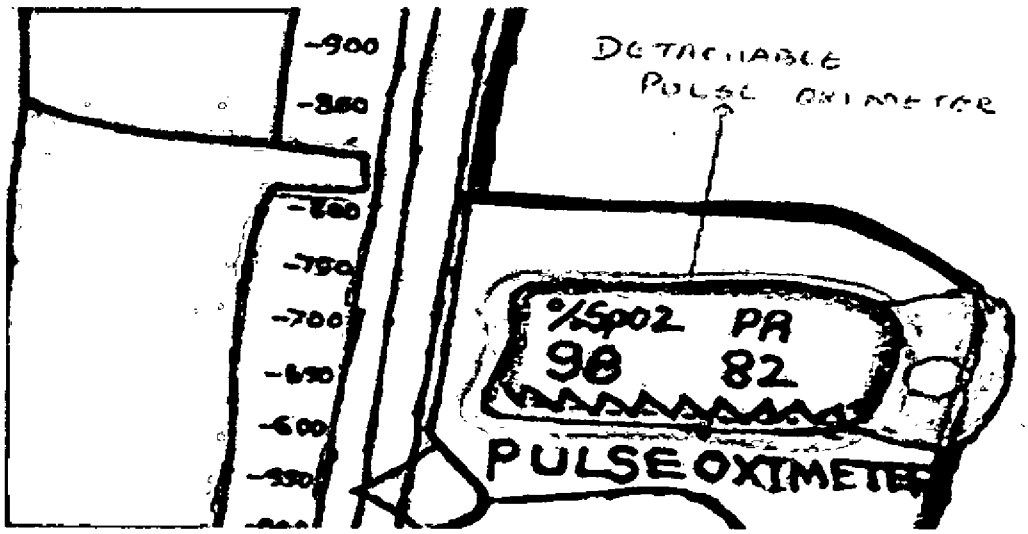

Fig 9

The motivational incentive spirometry has a special, detachable pulse oximeter at the left side which shows real time SPO2 during spirometry which helps to recognize the condition of the patient itself and at the same time, tachycardia can be identified by the patient or health workers to immediately stop using the device. During patient shifting and home setup also, this device can be used.

DIGITAL THERMOMETER;

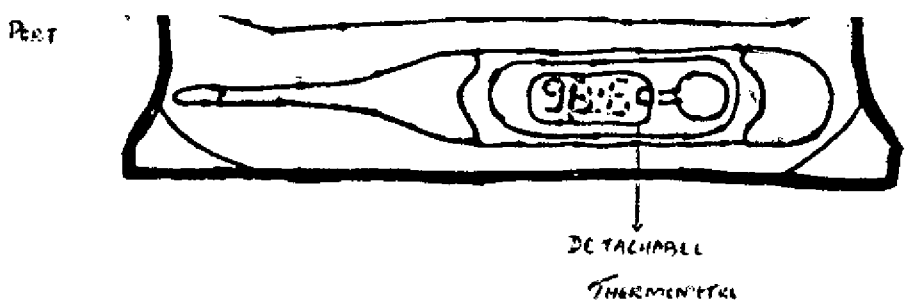

Fig 10

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The Device has an incorporated digital thermometer, which can be uses before incentive spirometry and when required

REMINDER ALARM CLOCK:

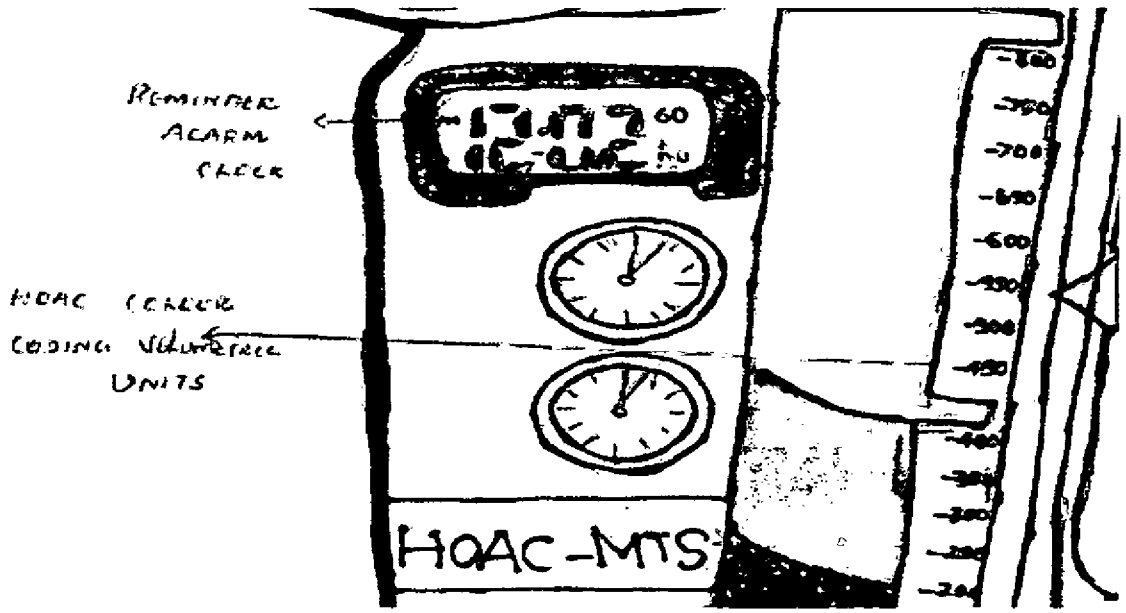

Fig 11

At the right-hand side, it has reminder alarm clock which is used in 3 ways which are explained as below:
Firstly, it helps to check on the spirometry inspiratory holding seconds.

Secondly, it has a facility in order to set a reminder for the next session to use the spirometry. This can be set by patients or health care workers which prevents the chances of negligence of using this device.

Thirdly, it has shows date, time, and day which will help to keep the patient oriented and reduce the chance of ICU induced delirium.

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SMILEY BALL FOR STRESS REDUCING:

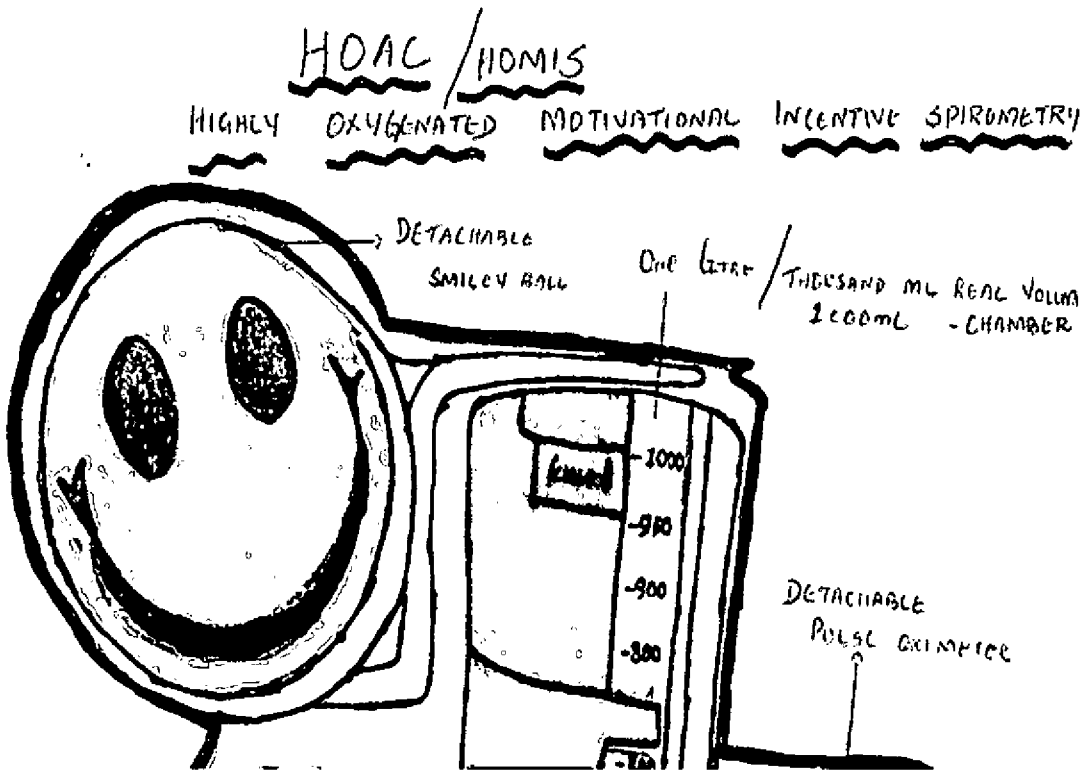

Fig 12

On the top of right side, a smiley ball is present which helps to decrease or reduce the level of tension or stress and elevates the mood of the patient especially because of the depressing pandemic disease either in home or ICU setup.

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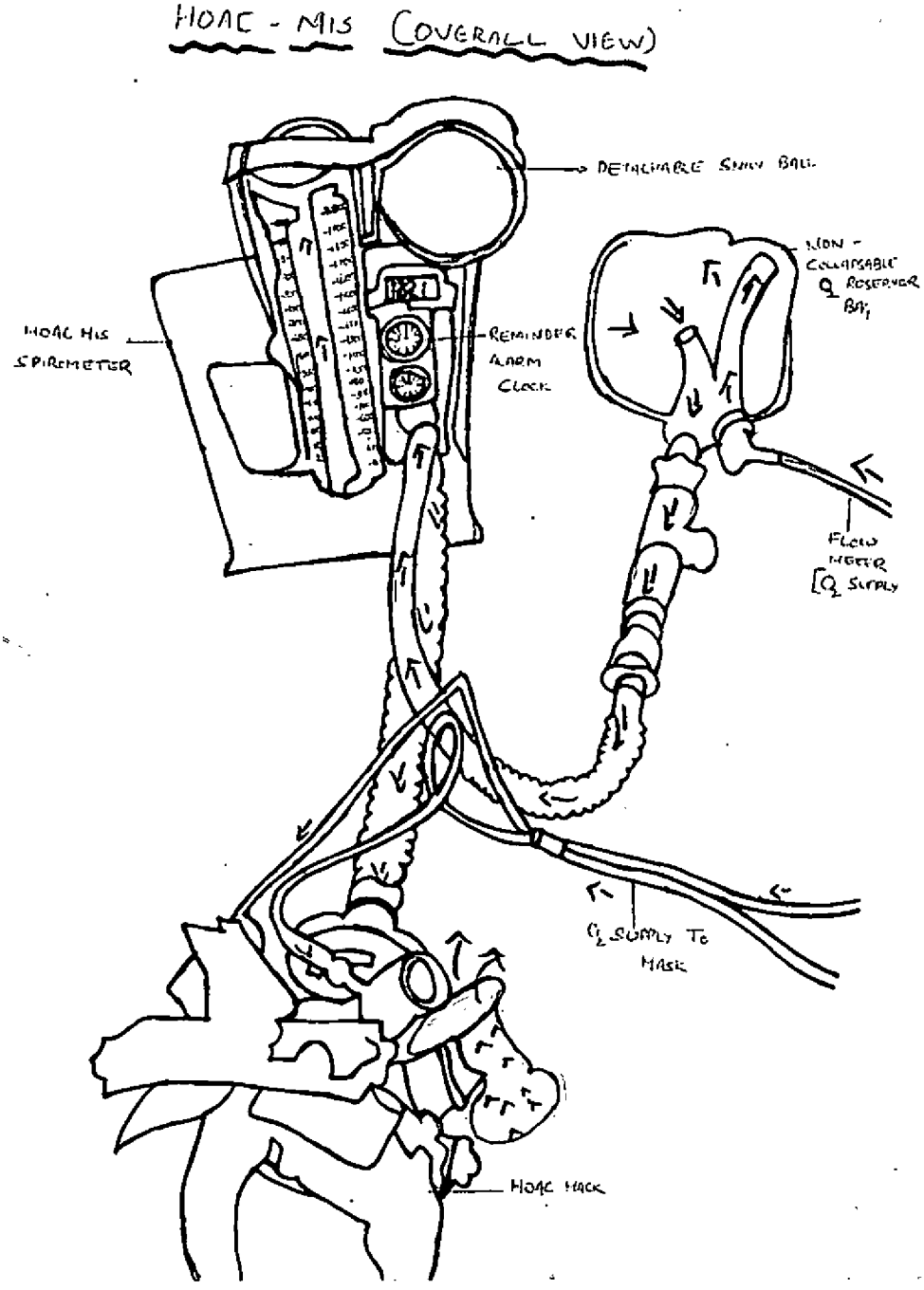

Fig 13 HOAC MIS Overall view (concept design)

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PART 3) NON-COLLAPSING RESERVOIR BAG

The NCR bag comprises of double lumen flexible tubular structures-

The first one is an inlet for oxygen supply and extends till middle of the bag and the second one extends till 1/3rd of the bag and connected to the inhalational port of HOAC Spirometer or the HOAC Mask with an intervening pressure releasing one-way valve.
It can provide humidified oxygen up to 15 L/min and is different from the normal reservoirs due to the following reasons:

i. The tubular structures are flexible and thus prevent collapse of neck and body of the bag and facilitate easy filling of the bag
ii. The pressure releasing valve helps in preventing of false reading during spirometry and rupture of the bag
iii. Oxygen inlet port is connected to flow meter with an intervening tri-way (the other port of the tri way is connected to inspiratory ports of HOAC mask which delivers oxygen during normal breathing)

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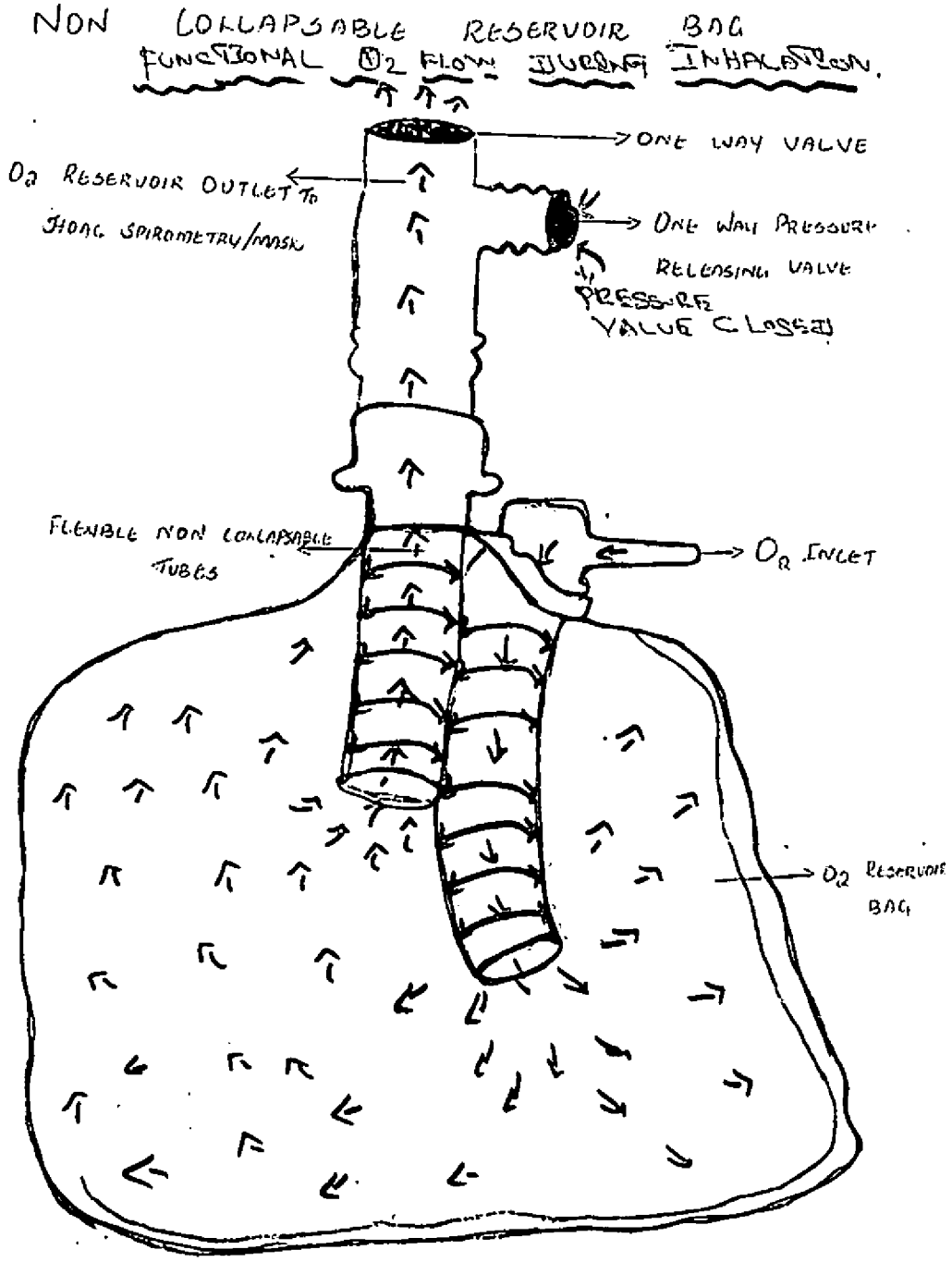

FIG 14(a): NCR Bag (concept design with flow of oxygen during inhalation)

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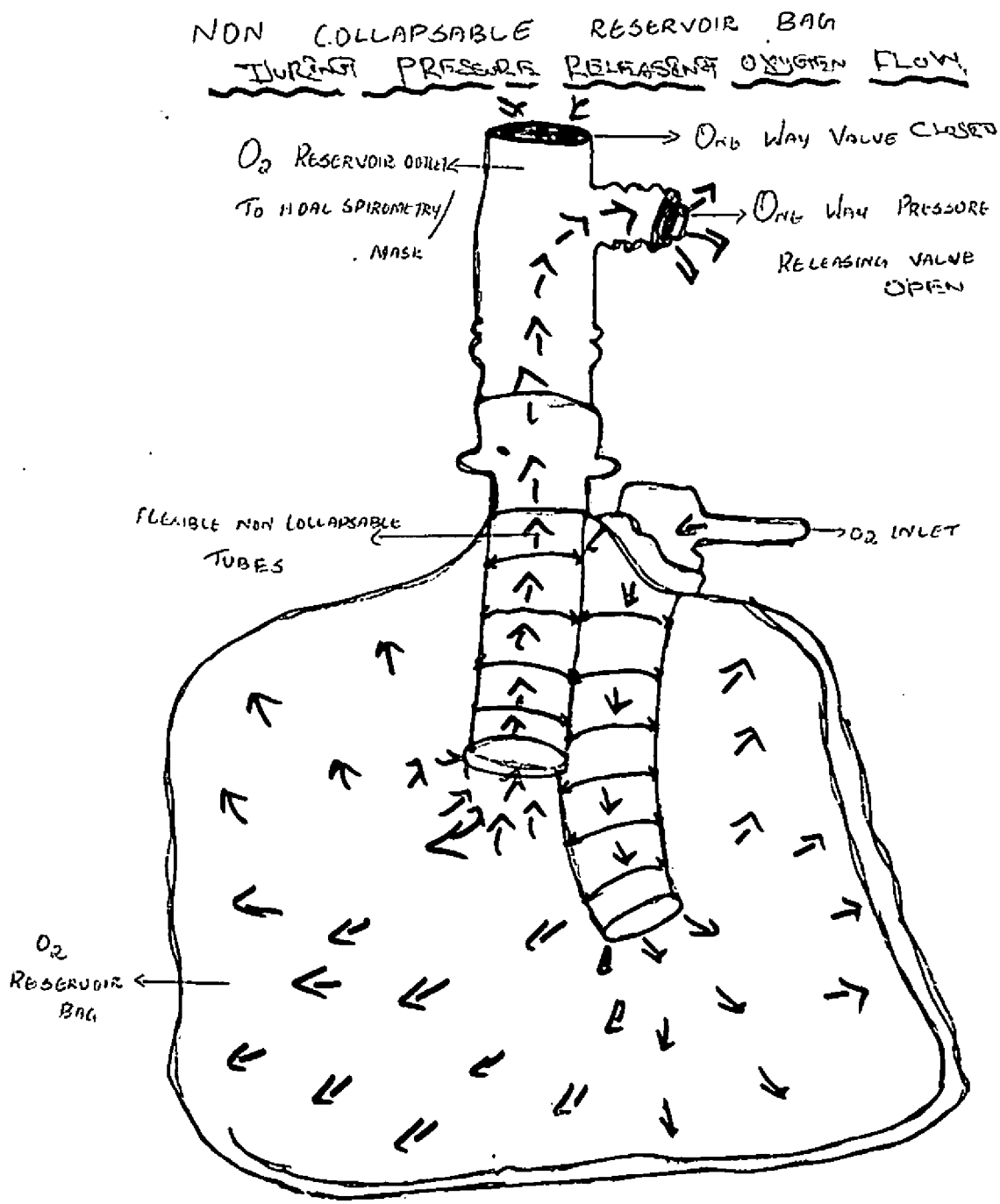

FIG 14(b): NCR Bag (concept design showing flow of oxygen during exhalation and release of the pressure through the valve)

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PART 4)ADVANCED NEBULIZATION CHAMBER

This chamber resembles the normally used chamber except as follows.

i) This is connected to the multifunctioning port of the HOAC Mask
ii) The attaching part of the unit has a one-way valve which prevents passage of aerosols into the nebulisation unit during expiration of the patient.
iii) This design also helps in saving the drug during the expiration phase of the patient.
iv) This has a small one way valve port for adding nebulisation drugs.

A protective cap is present to cover the mask end of the chamber to prevent contamination after usage.

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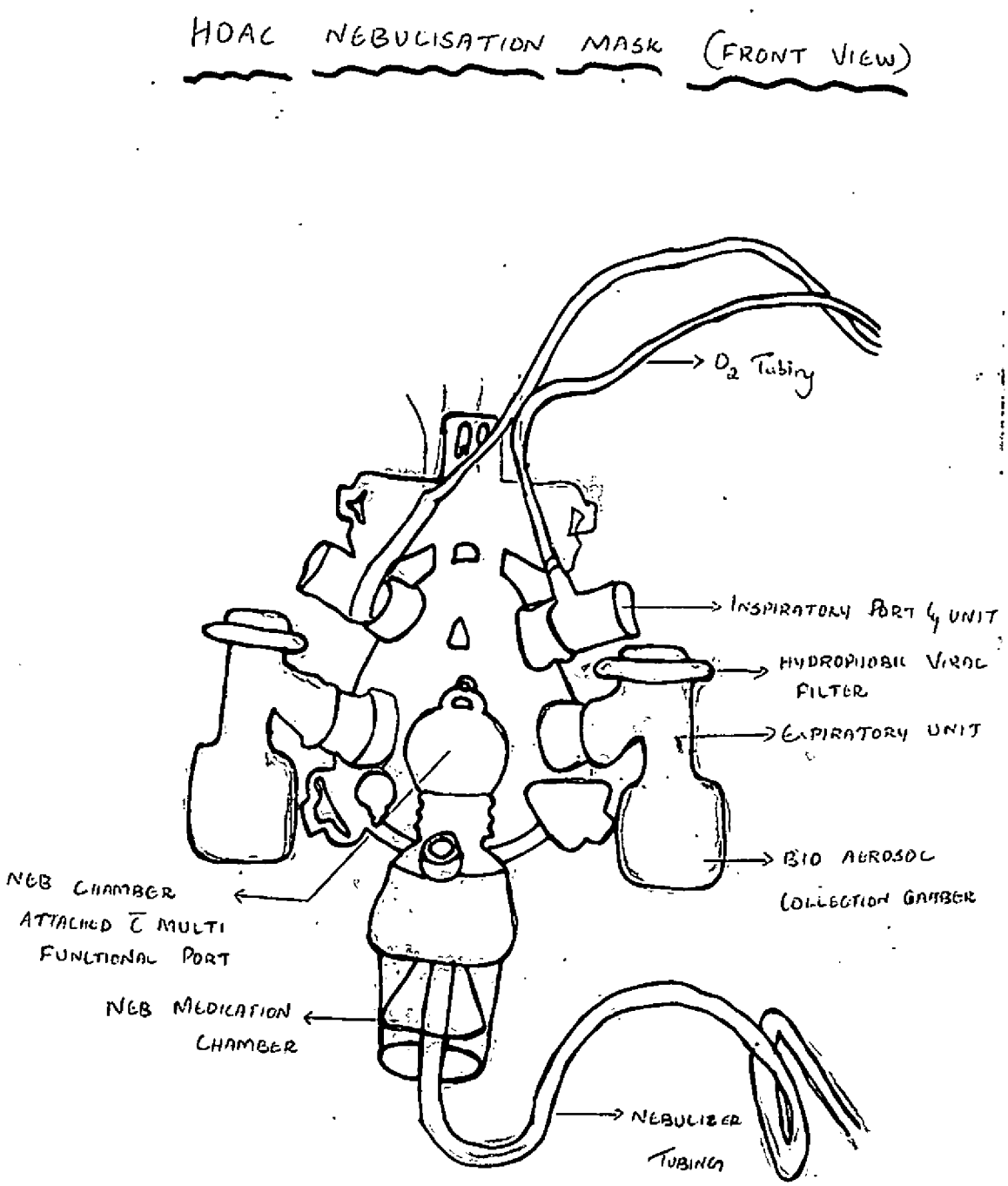

Fig 15(a):Theadvanced nebulization mask attached to the Multifunction port of the HOAC Mask (concept Design)

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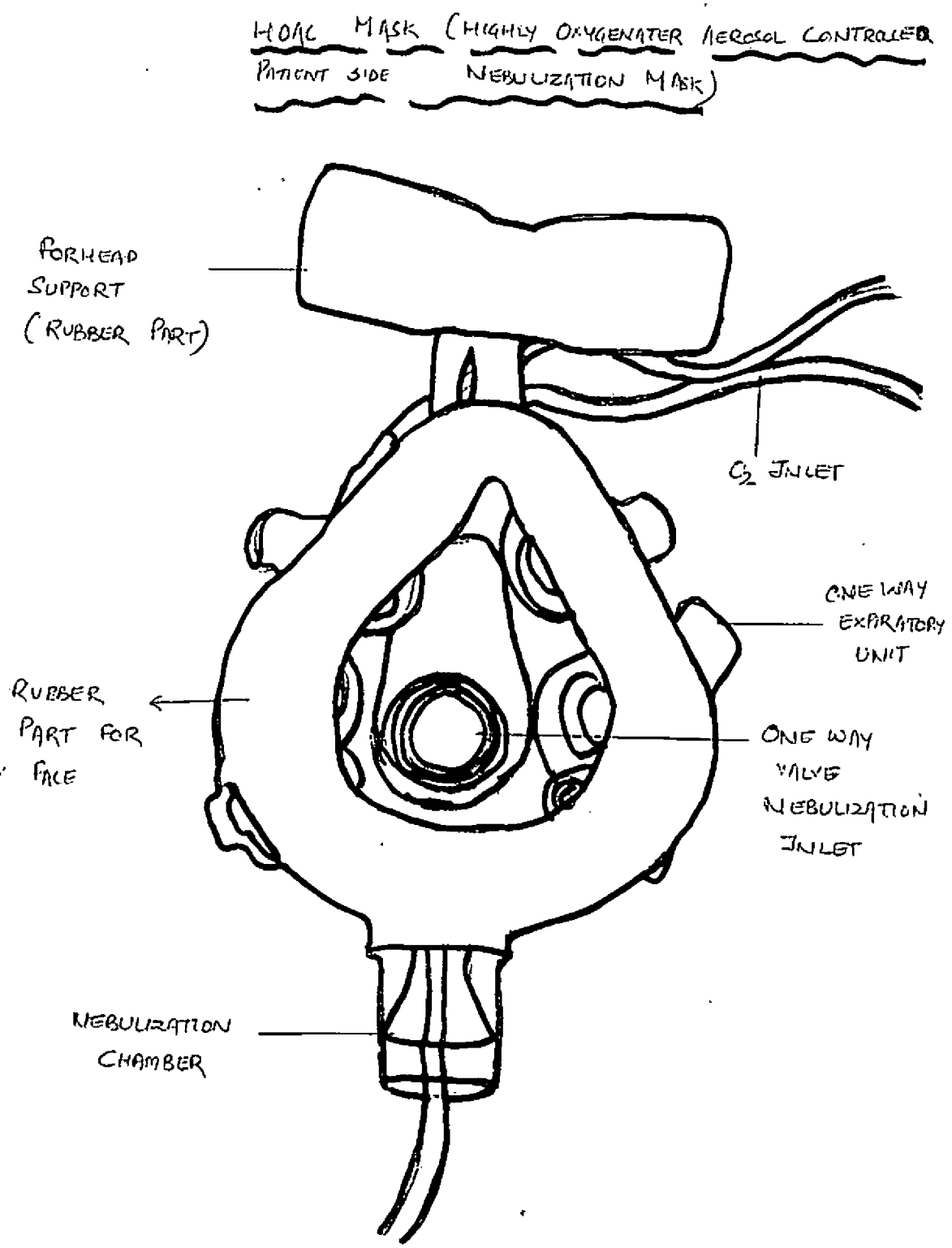
Fig 15(b): The Nebulization unit attached to the multifunction port of the HOAC Mask, as seen from patient end , The white coloredone-way valve is seen in the center



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HOAC - ADVANCED NEBULIZATION CHAMBER

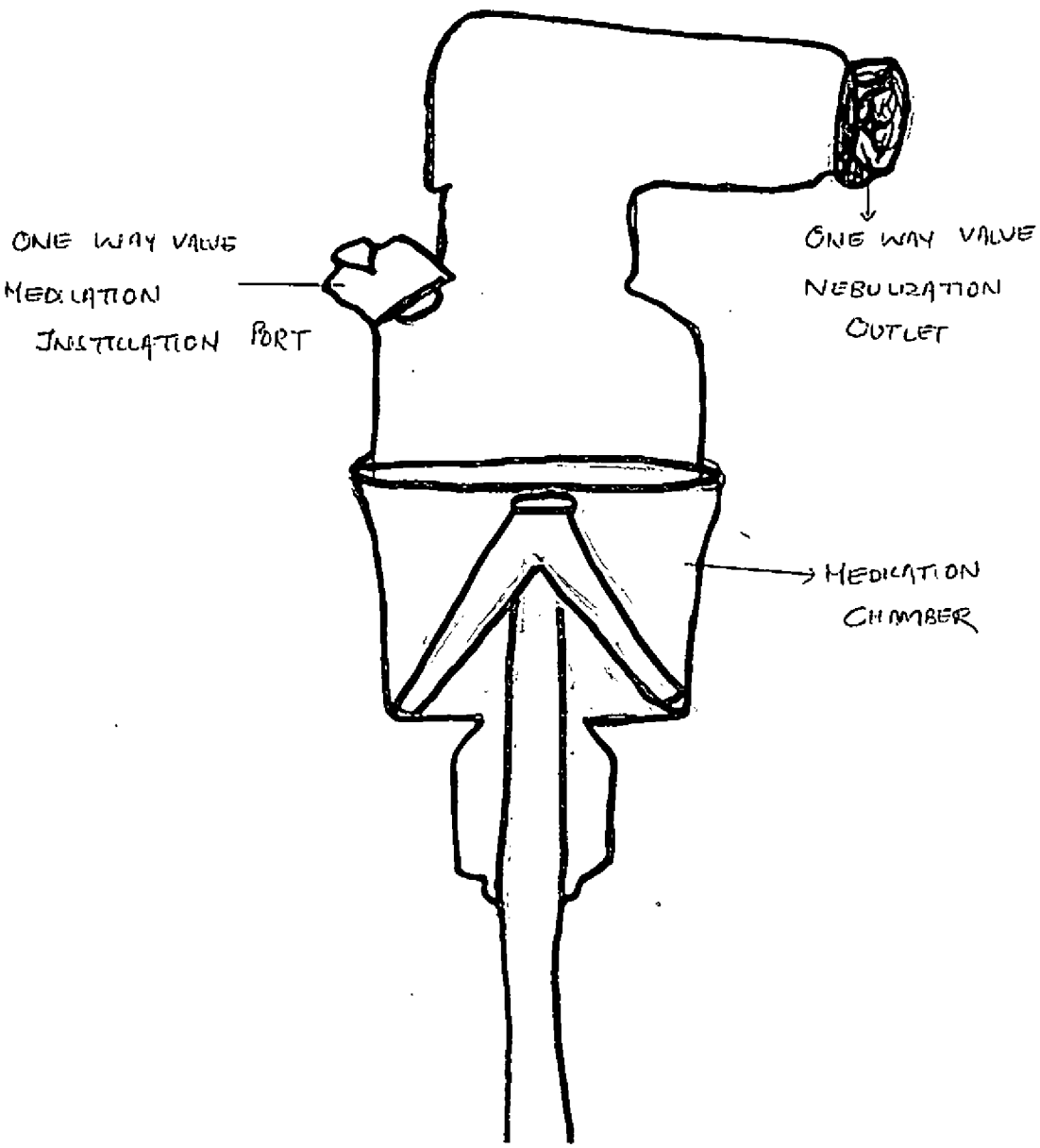

Fig 15(c) :The advanced Nebulisation unit, with the white colored one way valve (concept design)

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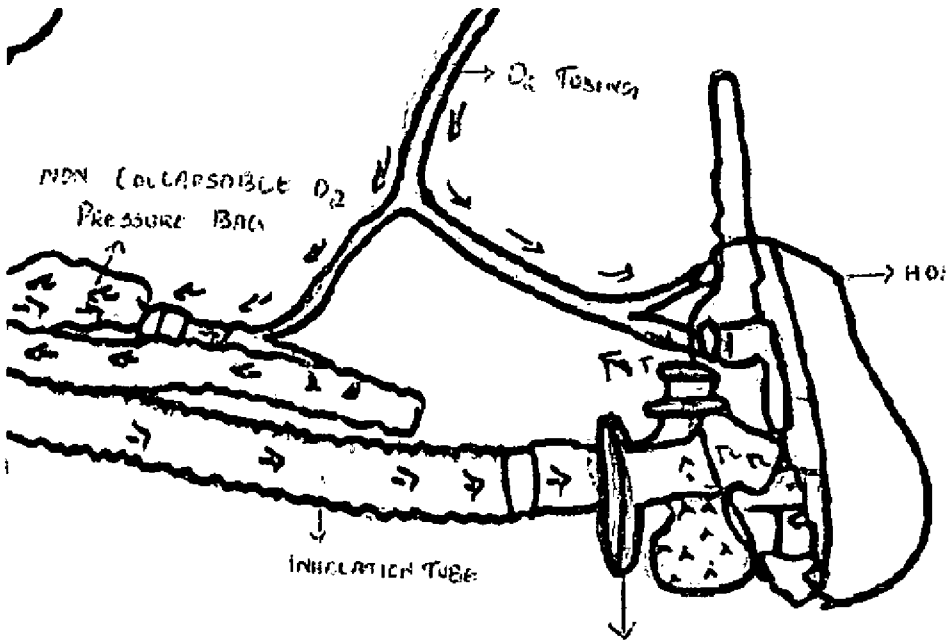
PART 5) <u>SPECIALIZED OXYGEN DELIVERY TUBING AND PROTECTIVE FABRIC</u>

There are three tubing in all.

A. a double Y tube which delivers oxygen to both the inspiratory ports and the Nebulisation chamber/NCRB (when high level of oxygen supply is required during nebulisation or spirometry)
B. A single Y tube – to deliver Oxygen only to inspiratory ports (when low oxygen is sufficient during nebulisation / spirometry)
C. A straight tube (connected to nebulisation chamber and nebuliser), when high oxygenation is not required during nebulisation.
D. Protective Cloth – to collect any sputum or aerosols if the patient coughs out after the procedure. It is made up of three-layered fabric and the central portion has an absorbing sponge like material. It can also be used to clean and sanitise the mask for reuse for the same patient

Fig



16: The double - Y tube in function (concept design)

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DESCRIPTION OF 5 METHODS OF USAGE IN HOAC COMBOUNITS:

INCENTIVE SPIROMETRY - HOAC MIS and HO MIS

HOAC MIS : Used when the patient has highly infectious disease like Covid -19 or other airborne diseases

HO MIS: Used when the patient does not have a highly infectious disease.

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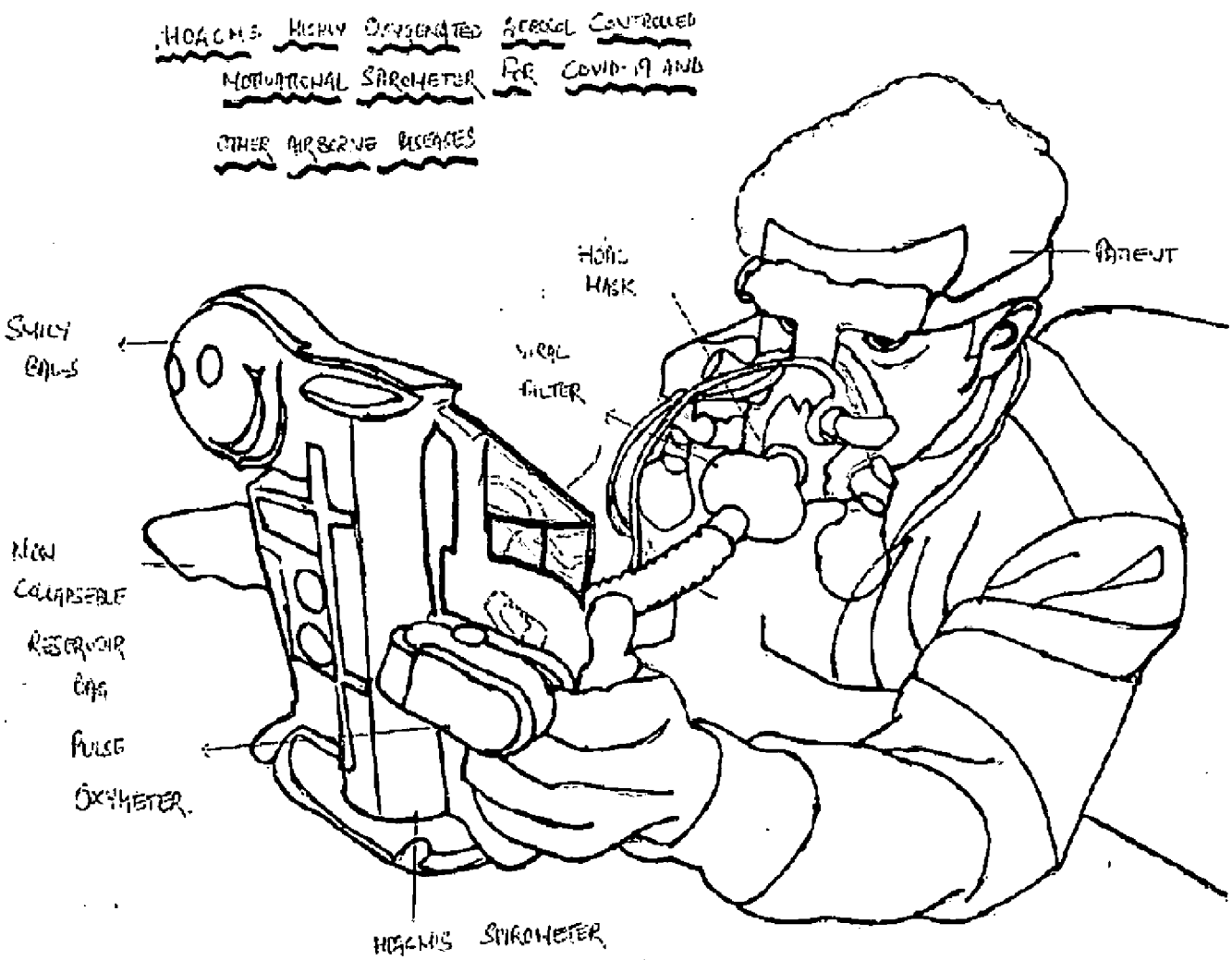

Fig 17: HOAC MIS in usage (concept design)

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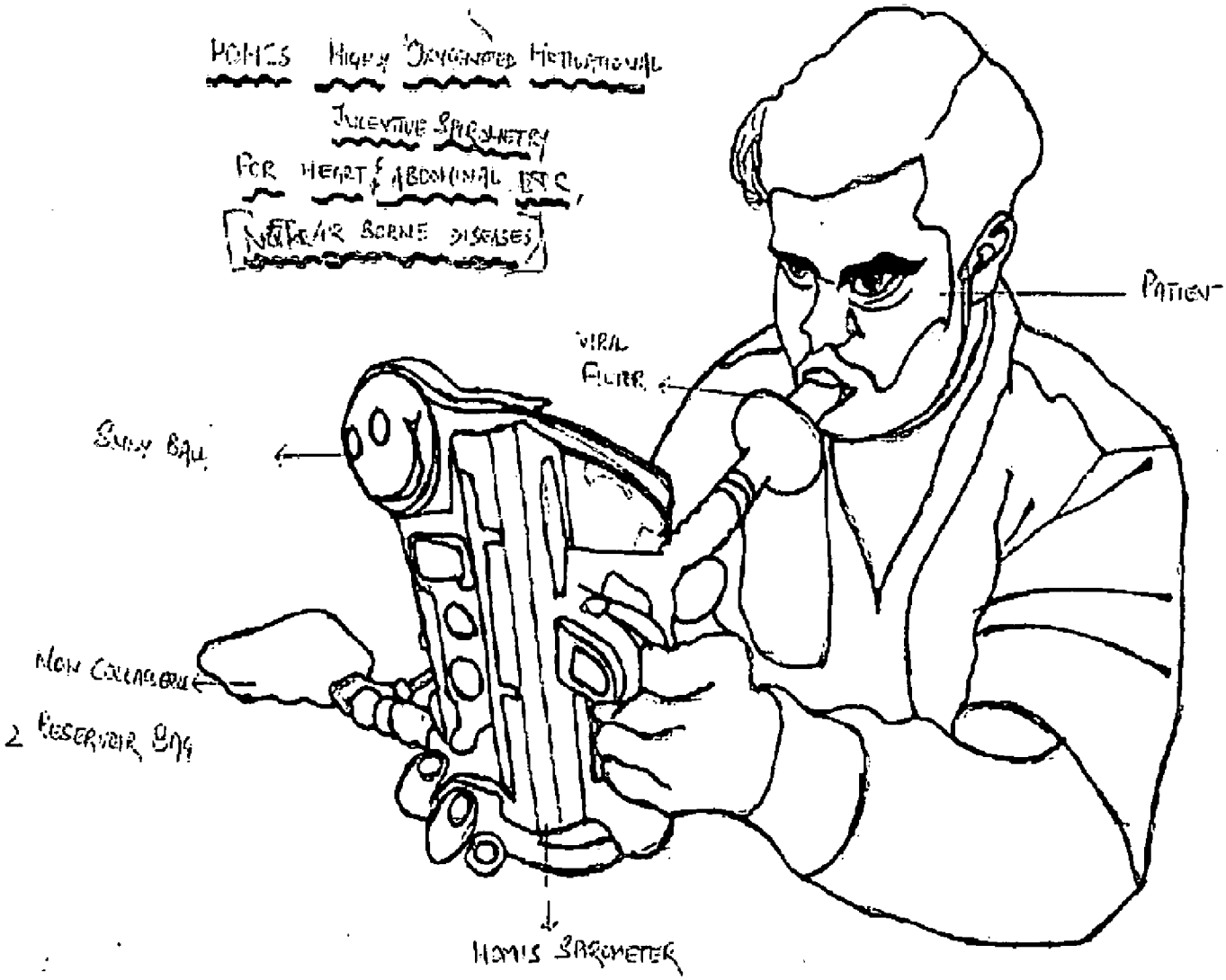

Fig 18: HO MIS is usage (Concept design)

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Incentive spirometry Procedure steps(Spirometry should not be done when the patient has fever which can be checked with provided digital thermometer)

1) SPIROMETRY WITH HIGH OXYGEN REQUIREMENT: HOAC MIS (closed system - usage with NCR bag)

a) connect the inflow end of double Y tube to the oxygen flowmeter and single outflow connected to oxygenation port of NCRB and double outflow connected to inspiratory ports of the HOAC mask

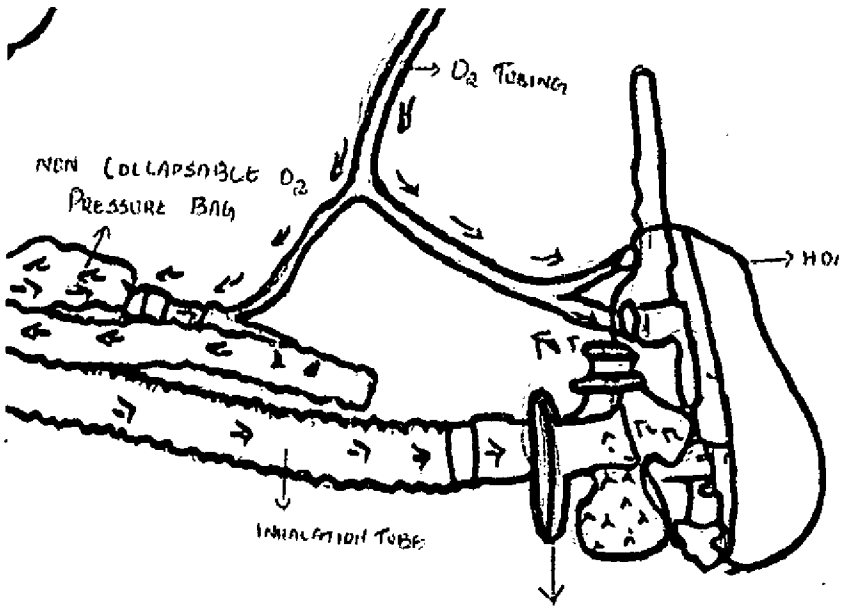

Fig 19

b) then attach NCRB's outlet to HOAC Spirometer's airflow inlet and spirometry mouthpiece attached to the multifunctional port of HOAC mask.

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c) Start the high oxygen flow as required.

2)SPIROMETRY WITH LOW OXYGEN REQUIREMENT; HOAC MIS (Open System - No NCR Bag attached)
Connect a double Y tube's inflow end to the flowmeter, single outflow connected to the oxygen port of spirometry and double outflow in the HOAC Mask's inspiratory oxygen inlet.

B. Attach the HOAC mask to the patient and secure it with straps. Ascertain good sealing around nose and mouth of the patient.

Rest of the steps are usually the same as normal incentive spirometry. The SPO2 and Heart rate should be monitored during the procedure

At the end of the HOACS procedure, the patient should take some normal breaths before disconnecting the mask (unless emergency) to minimize the spread of pathogens in the mask.

After the procedure is completed the straps should be loosened, oxygen flow should be reduced and then the mask can disconnect completely from the patient.

The protective cloth can be used for sanitizing the mask and also to cover the patient's mouth in case of coughing.

At last the spirometry's mouthpiece and mask should be capped and kept away for further usage. The reminder should be set for next usage.

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Differences between HOACMIS ,HOMISincentive Spirometry and Normal incentive Spirometry

Feature	HOAC SPIROMETRY	NORMAL SPIROMETRY	HOMIS
Applicability	Covid-19 and other droplet and airborne diseases (suspects and Positive)	Only in diseases without droplet or Airborne spread (only for Normal patients)	Only in diseases without droplet or Airborne spread (only for Normal patients)
Special features	Measures spo2 and heart rate ,digitalthermometer, Reminder alarm clock Smiley ball for stress buster	Not available in normal spirometer	Measures spo2 and heart rate ,digital thermometer, Reminder alarm clock Smiley ball for stress buster
Benefit 1	Useful as Aerosol controlling system where the disease spread is inhibited	Aerosols are not controlled; hence disease spread is possible	Aerosols are not controlled; hence disease spread is possible
Benefit 2	The system prevents catching disease from the atmosphere	The patient is exposed and can acquire disease from others	The system prevents catching disease from the atmosphere
Benefit 3	Can be used with high flow, low flow and without Oxygen flow as per the requirement	Can be used only with low flow and without oxygen requirement	Can be used with high flow (nasal prongs for patient, and straight tube between flowmeter and NCR Bag) low flow(straight tube between flowmeter and Oxygen port of Spirometer) and without Oxygen flow as per the requirement
Benefit 4	100% oxygen FiO2 can be maintained during spirometry	100% FiO2 is not possible	100% oxygen FiO2 can be maintained during spirometry
Benefit 5	ETCO2 can monitored during spirometry	Cannot be monitored	Cannot be monitored
Benefit 6	The Chamber is big in size and	It does not	The Chamber is big in size and

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	shows the actual inhaled volume. This also has the reading of a normal Spirometer (when open system is used)	show the actual inhaled volume.	shows the actual inhaled volume. This also has the reading of a normal Spirometer (when open system is used)
Benefit 7	Color coding system to indirectly show the patient condition to health professionals and motivate the patient.	There is no such feature	Color coding system to indirectly show the patient condition to health professionals and motivate the patient.
Drawback	The device has to be attached tightly for good efficacy, and cannot be used in patients with facial trauma or in children.		

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AEROSOL CONTROLLED HIGHLY OXYGENATED NEBULIZATION (HOAC-N)

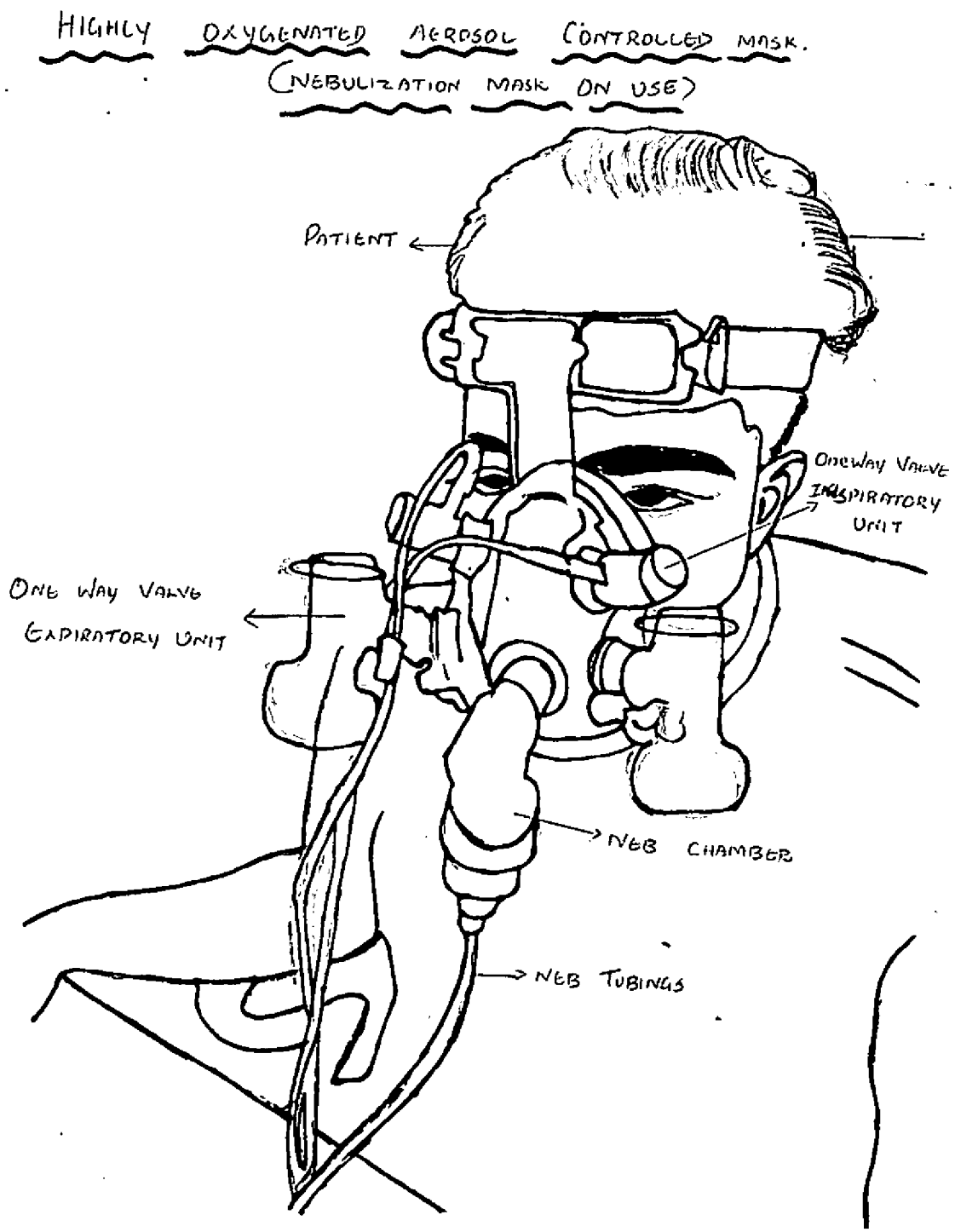

Fig 20: HOAC Nebulisation in use (Concept Design)

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Feature	HOAC NREBULIZATINON MASK	NORMAL NEBULIZATION MASK
Aerosol Control	Aerosols are controlled	Not controlled
Uses	Suspects & Positive	Only for Normal patients
Oxygen supplementation	Can be used in patients requiring, high, low oxygen supply	Can be used only in patients requiring low and no oxygen supply
Drug loss	The nebuliser drug is not lost to the atmosphere	A lot of drug is lost during the procedure
Contamination	One-way drug instilling port prevents contamination from healthcare workers	Contamination possible
Chamber Contamination	The expired air does not reach the nebulisation chamber; therefore, the chamber is not contaminated	Possibility of the chamber contamination is present
ETCO2 Measurement	Possible during the procedure	Not Possible

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AEROSOL CONTROL NON-RE-BREATHER MASK (ACNRBM) FOR SHIFTING OF PATIENTS WITH COVID 19 AND AIRBORNE DISEASES

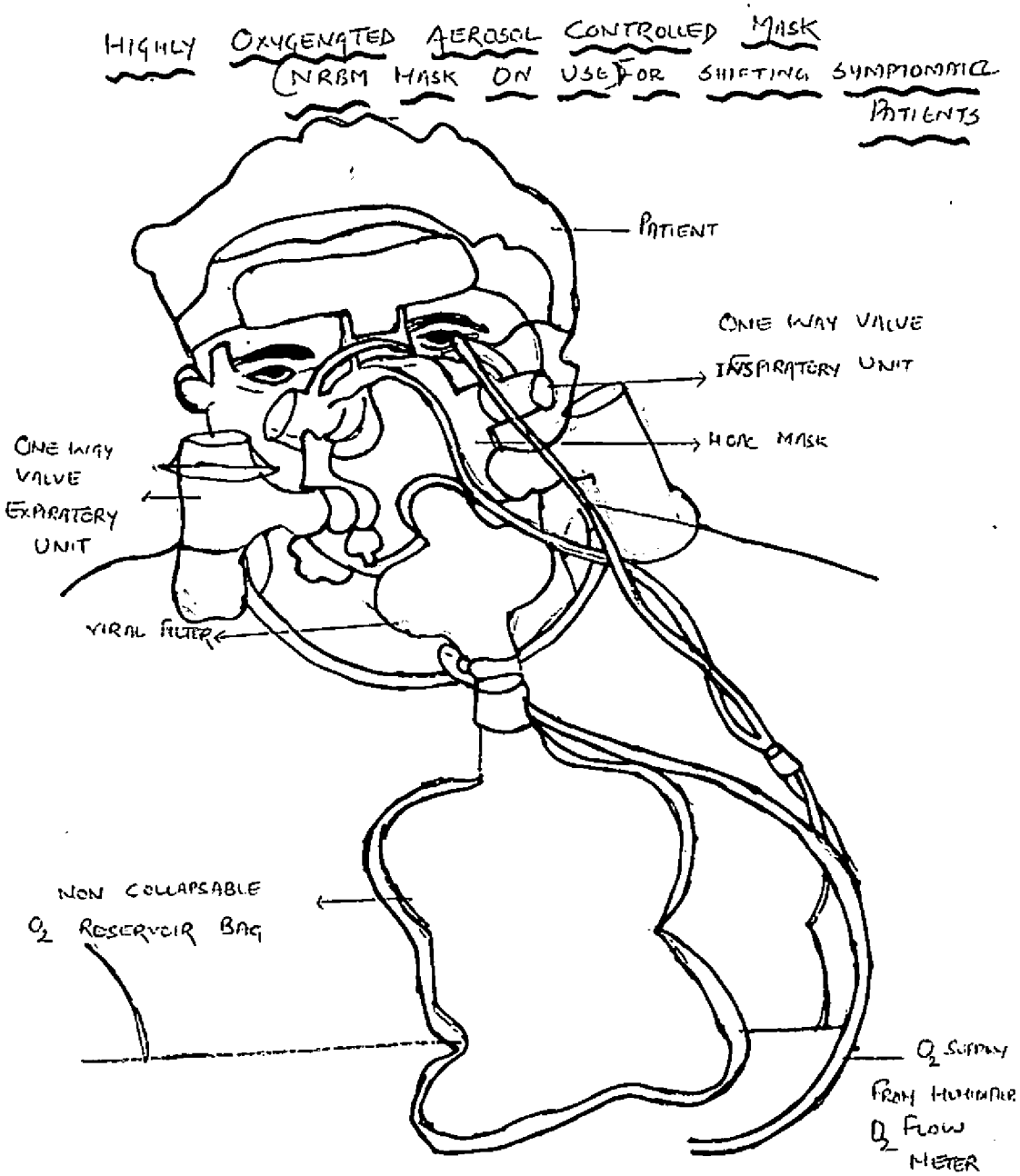

Fig 21 AC NRBM in use during shifting of patient usually on Face mask (Concept design)

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When a symptomatic patient with Covid 19 or any other airborne disease who is Face mask support, needs to be shifted from one hospital to another or from one ward to another ward of the same hospital, ACNRBM should be attached.

CONNECTIONS

a. connect the inflow end of double Y tube to the oxygen flowmeter in portable oxygen cylinder and single outflow end is connected to oxygen port of NCRB and double outflow end is connected to inspiratory ports of HOAC mask

b) then attach NCRB with viral filter to multifunctional port of HOAC mask

c) Start the high oxygen flow as required.

d) Attach the HOAC mask to the patient and secure it with straps. Ascertain good sealing around nose and mouth of the patient.

e) now the patient is ready for shifting in respective receiving hospitals or ward/ ICU

f) After the shifting is completed the straps should be loosened, oxygen flow should be reduced and then the mask can disconnect completely from the patient and normal face mask can be attached.

Difference between ACNRBM and Normal FACE MASK during shifting ;

Feature	AC NRBM	SIMPLE OXYGEN FACE MASK
Uses	Specialised for Symptomatic Covid – 19 and other airborne and droplet spreading disease	Only for low infectivity patients
Uses	Suspects and Positive	Only for low infectivity patients
During Shifting	This prevents spread of aerosols	Does not prevent the spread
Structure	Prevents twisting/kinking of the neck and collapse of bag	Not applicable
Structure	The oxygen inlet to bag and outlet towards patient are different	Not applicable
Structure	Prevents the direct spillage on face	
Oxygen failure	The patient can breathe even if the oxygen supply is stopped	The patient can breathe even if the oxygen supply is stopped

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AEROSOL CONTROL FACE MASK (ACFM) FOR SHIFTING OF PATIENTS WITH COVID 19 AND AIRBORNE DISEASES

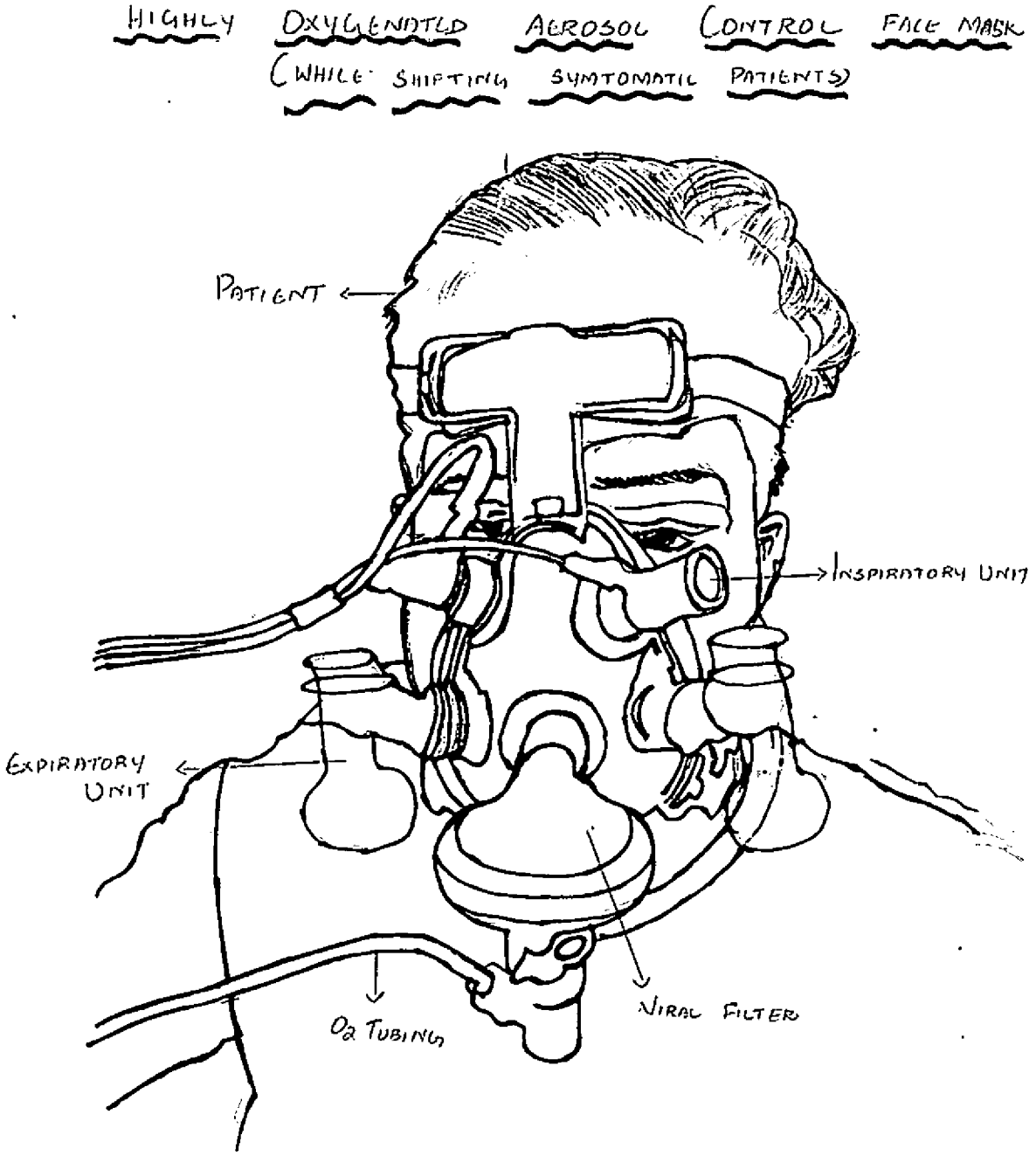

Fig 22: AC Face Mask usage (for patients on Room air or Nasal prongs symptomatic patients) (concept design)

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When a patient with Covid 19 or any other airborne disease who needs the support of Nasal prongs has to be shifted from one hospital to another or from one ward to another of the same hospital, a viral filtered oxygen inlet is attached to the multi-functional port of the same structure. And then it acts as an aerosol control FM.

CONNECTIONS

a) connect the inflow end of double Y tube to the oxygen flowmeter in portable oxygen cylinder and single outflow connected to viral filtered oxygen inlet in multifunctional port of HOAC mask and double outflow connected to inspiratory of HOAC mask
c) Start the oxygen flow as required.

d) Attach the HOAC mask to the patient and secure it with straps. Ascertain good sealing around nose and mouth of the patient.

E) now the patient ready for shifting in respective receiving hospitals or ward/ ICU

F) After the shifting is completed the straps should be loosen, oxygen flow should be reduced and then the mask can disconnect completely from the patients and immediately attached to the nasal prongs
Difference Between AC Face Mask and Nasal prongs

Feature	AC FACE MASK	NSAL CANNULA/ NASAL PRONGS
Uses	Specialised for Symptomatic Covid – 19 and other airborne and droplet spreading disease	Only for low infectivity patients
Uses	Suspects & Positive	Not applicable
During Shifting	This prevents spread of aerosols	Does not prevent the spread

NON-INVASIVE VENTILATION MASK;

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NON-INVASIVE VENTILATION MASK;

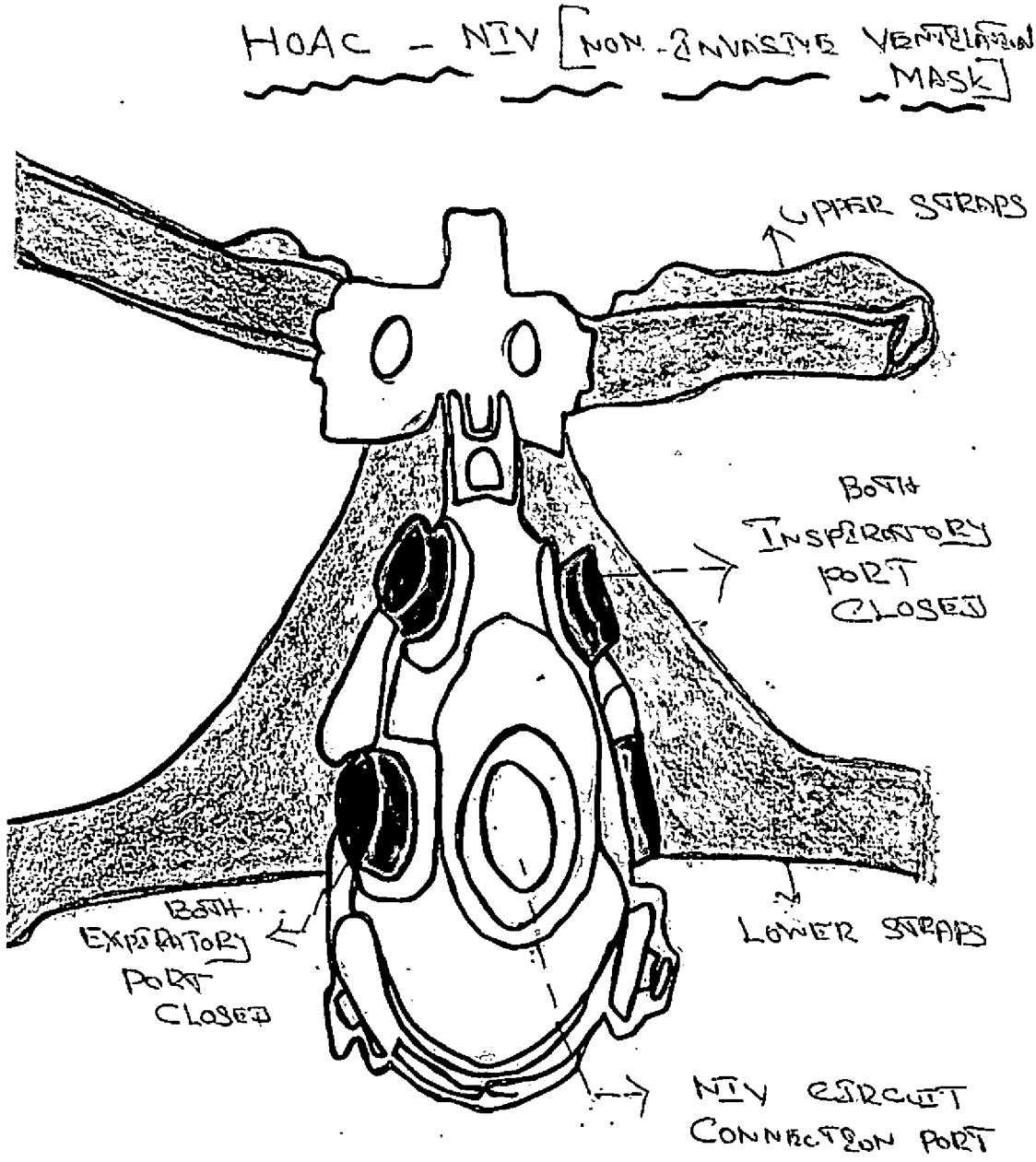

Fig 23: NIV MASK USAGE (concept design)

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NIV MASK

If the patient is not maintaining oxygen saturation with FM or NRBM and requires Non-Invasive Ventilation Mask (NIVM), the same design serves the purpose. Remove the two inlets, two outlets and close it tightly with appropriately sized caps and then it is ready to act as a NIV mask.

If the patients got negative from covid19 and other airborne diseases mean

The mask, spirometer, nebulization chamber and the oxygen reservoir and tubing can be reused after removing the viral filter and Ethylene Oxide (ETO) sterilization for the same patient. So here advantages HOAC COMO can be used for susceptive, positive and post negative with or without oxygen and home Isolating and treatment patients.

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ABSTRACT OF HOAC COMBO DEVICE INVENTION;

Highly Oxygenated Aerosol Controlled(HOAC) Combo Device for COVID-19 and Air borne diseases .

This **HOAC combo** unit allows for Incentive volumetric spirometry and Nebulization of a COVID 19 positive or other airborne disease patient without any aerosol generation. This allows for delivery of high flow of oxygen. **These components can be used for 6 purposes with connection changes. This leads to it being called as a combo unit**

1. **Highly Oxygenated Aerosol Controlled Motivational Incentive Spirometry (HOAC MIS)**
   (covid-19 and Airborne diseases patients)
2. **Highly Oxygenated Motivational Incentive Spirometry (HOAC MIS)**
   (post recovered covid-19 , Airborne diseases and postoperative heart ,lungs & abdominal patients)
3. **High Oxygenation Aerosol Controlled Nebulization (HOAC N)**
4. **Aerosol Controlled NRBM Usage (AC NRBM)**
5. **Aerosol Controlled Face Mask (AC FM)**
6. **Usual NIV mask**

It prevent or slow down the progression of the disease from mild to moderate stage or from moderate to severe stage of the COVID-19 And Airborne diseases.

It reduce the incidence of spread of covid-19 and Air borne disease from a known patient to other patients and to health care workers by reduction of aerosol production.

THE MAIN FOCUS OF HOAC DEVICE IS TO REDUCE THE MORTALITY RATE INSTEAD OF REDUCING MORBIDITY RATE (LIFE SAVING APPROACH)

INVENTOR 26/3/21

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PART 1) DESCRIPTION OF HOAC MASK DESIGN (HOAC M: Highly Oxygenated Aerosol Controlled Mask)

The mask is similar to a normal NIV mask manufactured according to the size of patient's face- small, medium, large. It has a silicone Gel material at the nose bridge area for prevention of Pressure Sores on the nose bridge. It is connected to an oxygen supply and after connection, is fully sealed to the face of patient with the help of adjustable straps. The mask has 5 ports in it(2 insp,2 exp,1 multi), each having its own distinguished function and different size in diameter.

A) Inspiratory Ports – 2 in number(Medium size)

B) Multifunctional Port – 1 in number

C) Expiratory Ports – 2 in number(Large size)

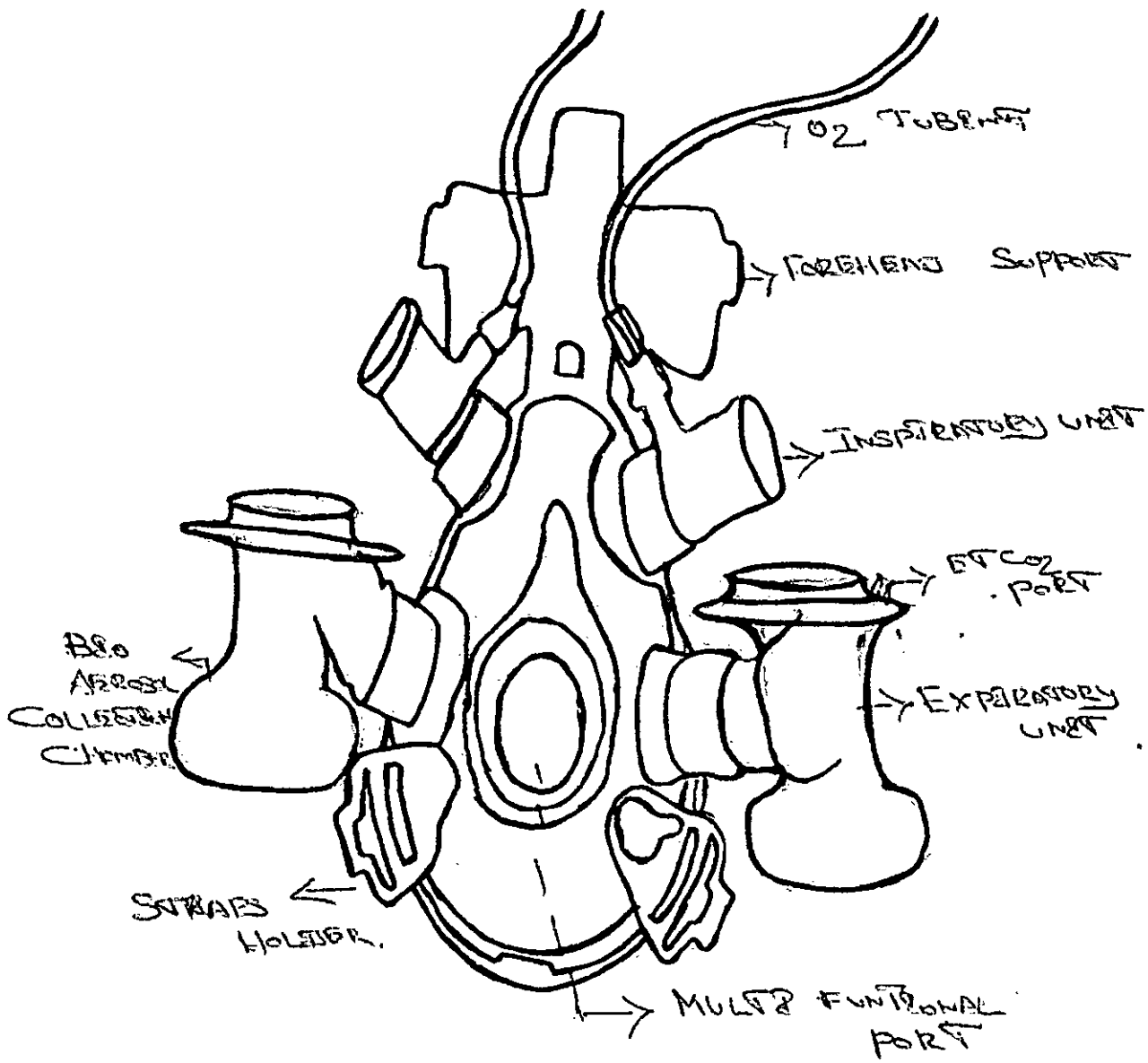

Fig 1 (a) : Concept Design of the HOAC MASK

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The HOAC mask Functional Air Flow

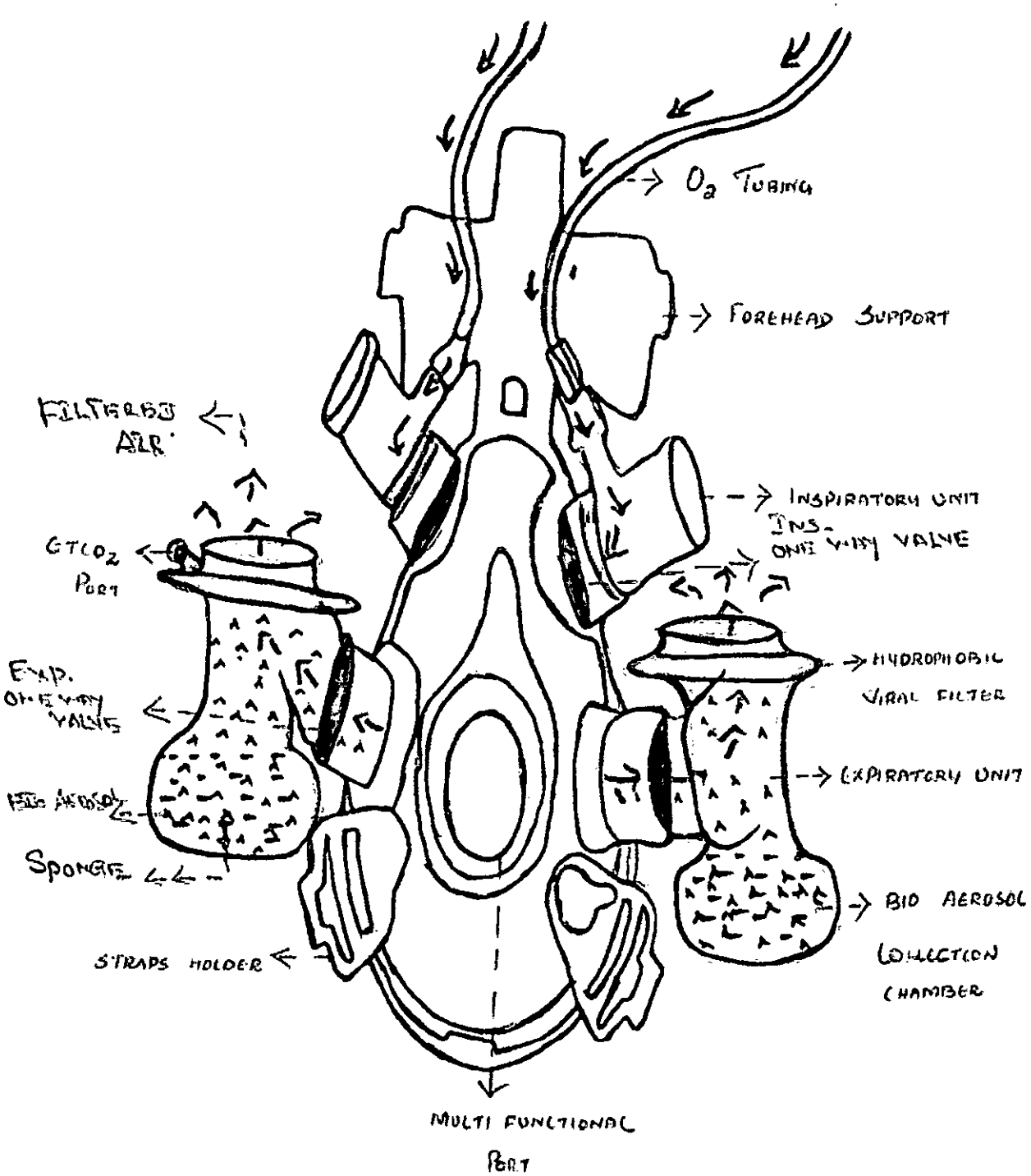

Figure 1 (b): The HOAC Mask in concept of Function

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HOAC-MASK Patient side view in Incentive spirometry(HOAC-MIS)

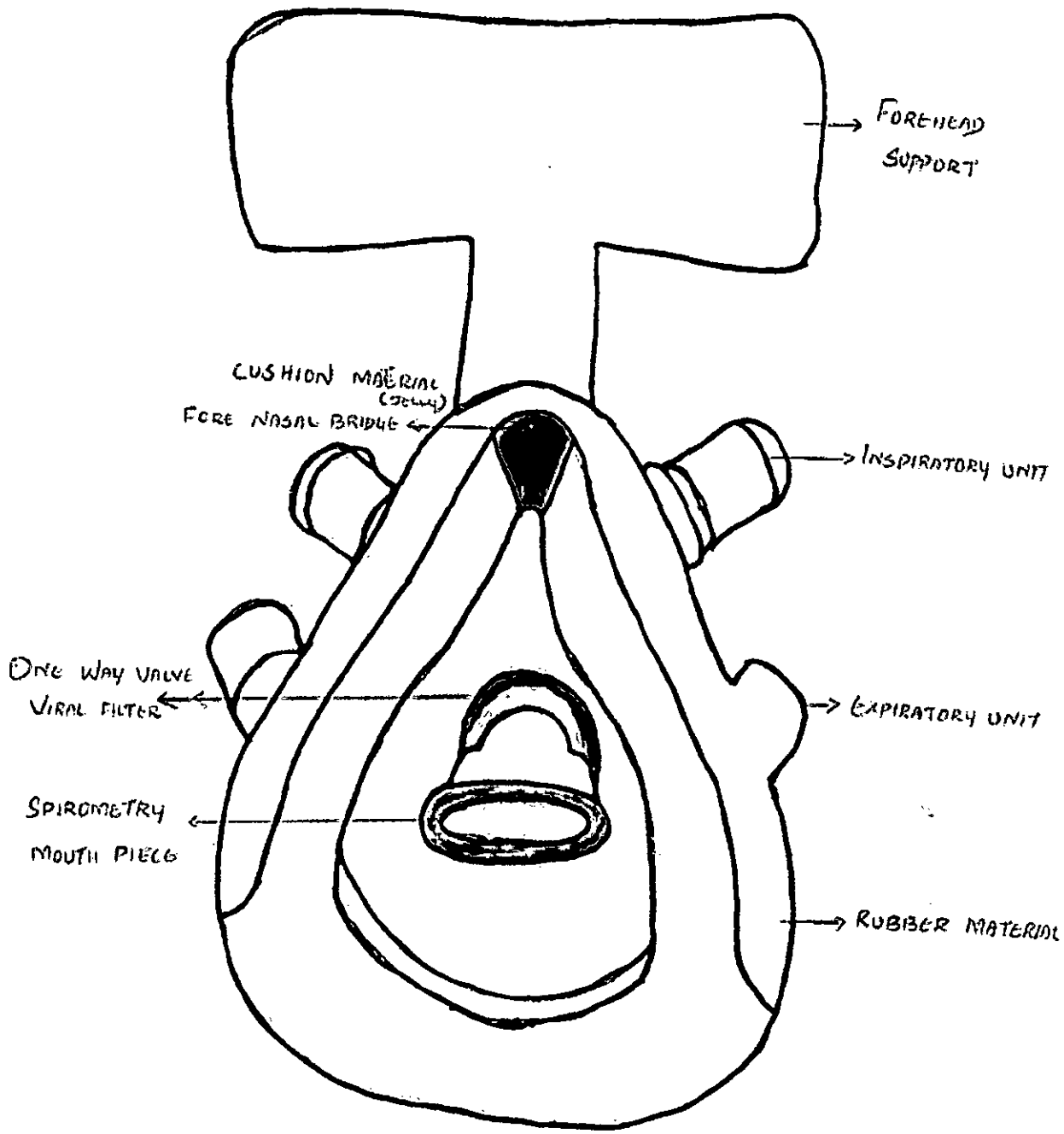

Fig 2 HOAC Mask Concept design as seen from patient end

HOAC MASK has a protective cap is there to cover the patient end of the HOAC Mask to safeguard for next usage (After every procedure)

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A) **INSPIRATORY PORTS**: The inspiratory ports are alongside the nose of the patient bilaterally and detachable inspiratory units are fitted in these ports. These units help in delivering the oxygen from the flowmeter to the mask during inspiration according to the patient's demand. The inner side of the unit has a viral filter and one-way valve which opens only on inspiration to deliver filtered highly concentrated oxygen and closes on expiration. The outer portion of the unit is in contact with the atmosphere through a dust filter, diverting the oxygen flow towards the atmosphere when the patient is expiring. In case the oxygen delivery falls, the unit can deliver filtered atmospheric air for inspiration.

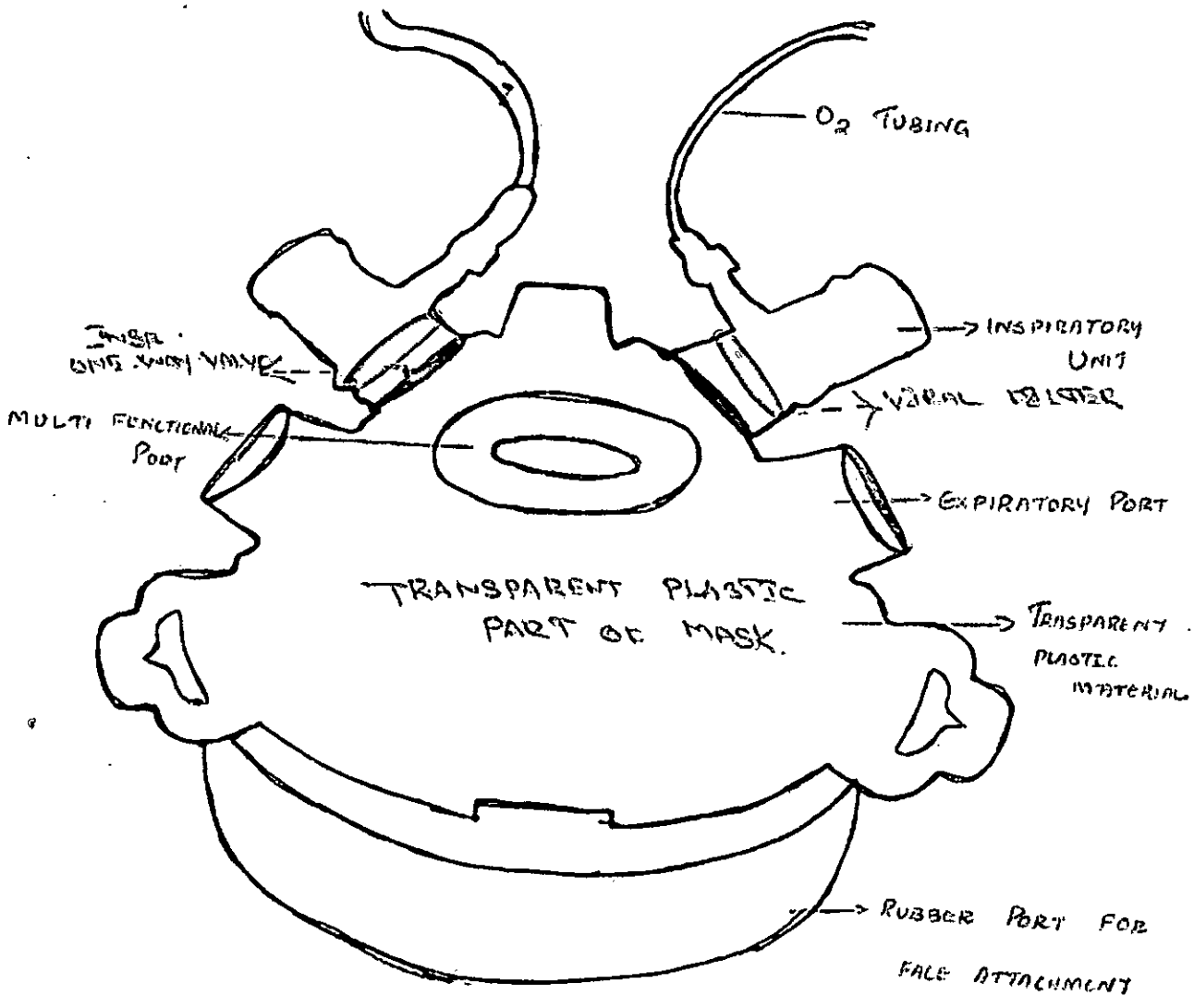

Fig 3 : Inspiratory Ports in position in the HOAC MASK

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INSPIRATORY PORTS:

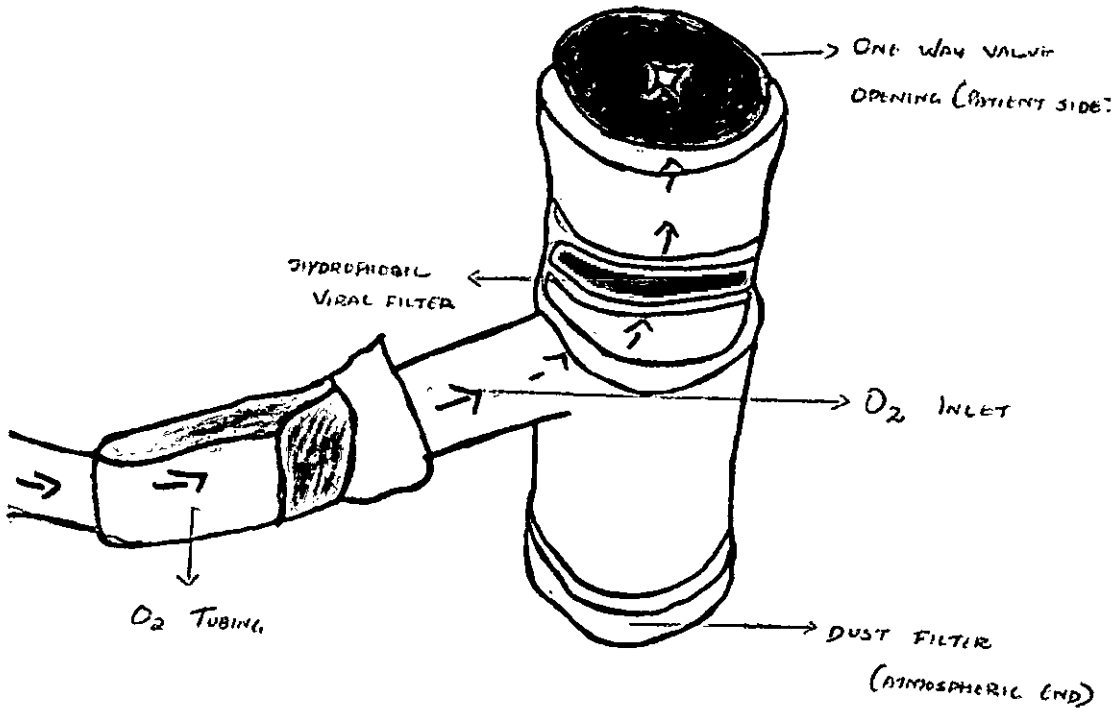

Fig 4: Inspiratory Ports Concept Design

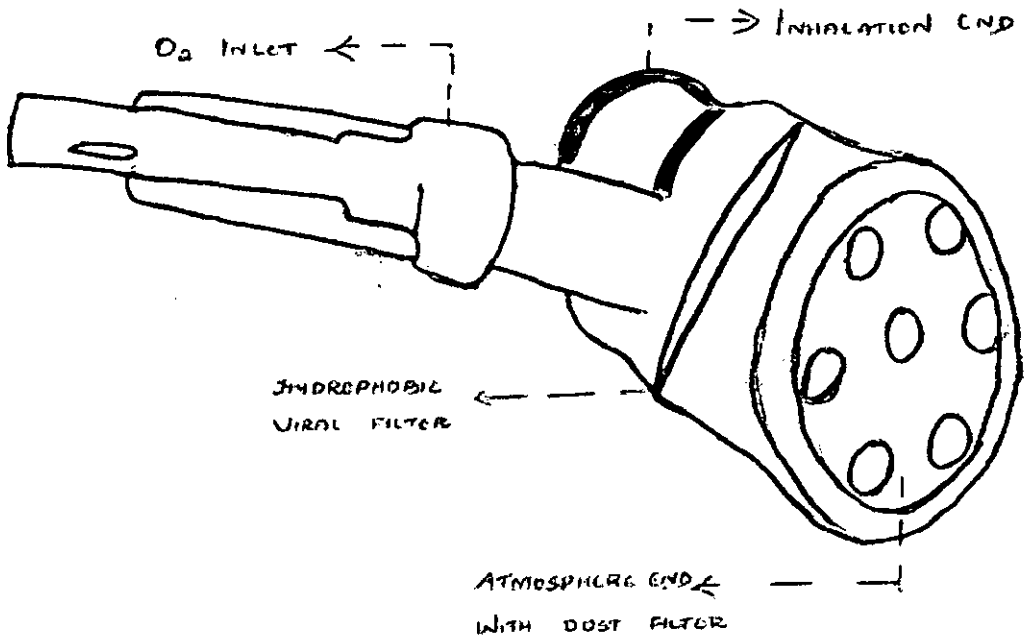

Fig 5 : Inspiratory Port Concept Design (Atmospheric End)

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B)MULTI-FUNCTIONAL PORT: The multi-functional port in HOAC Mask has the possibility to get attached spirometer's mouthpiece (during Spirometry), Nebulisation inlet (during nebulisation), NCRB (when being used as NRBM), Oxygen inlet (usage as Face Mask), and Ventilator tubing (using as NIV). This port is attached to the respective end with an intervening viral filter in all cases except during nebulisation.

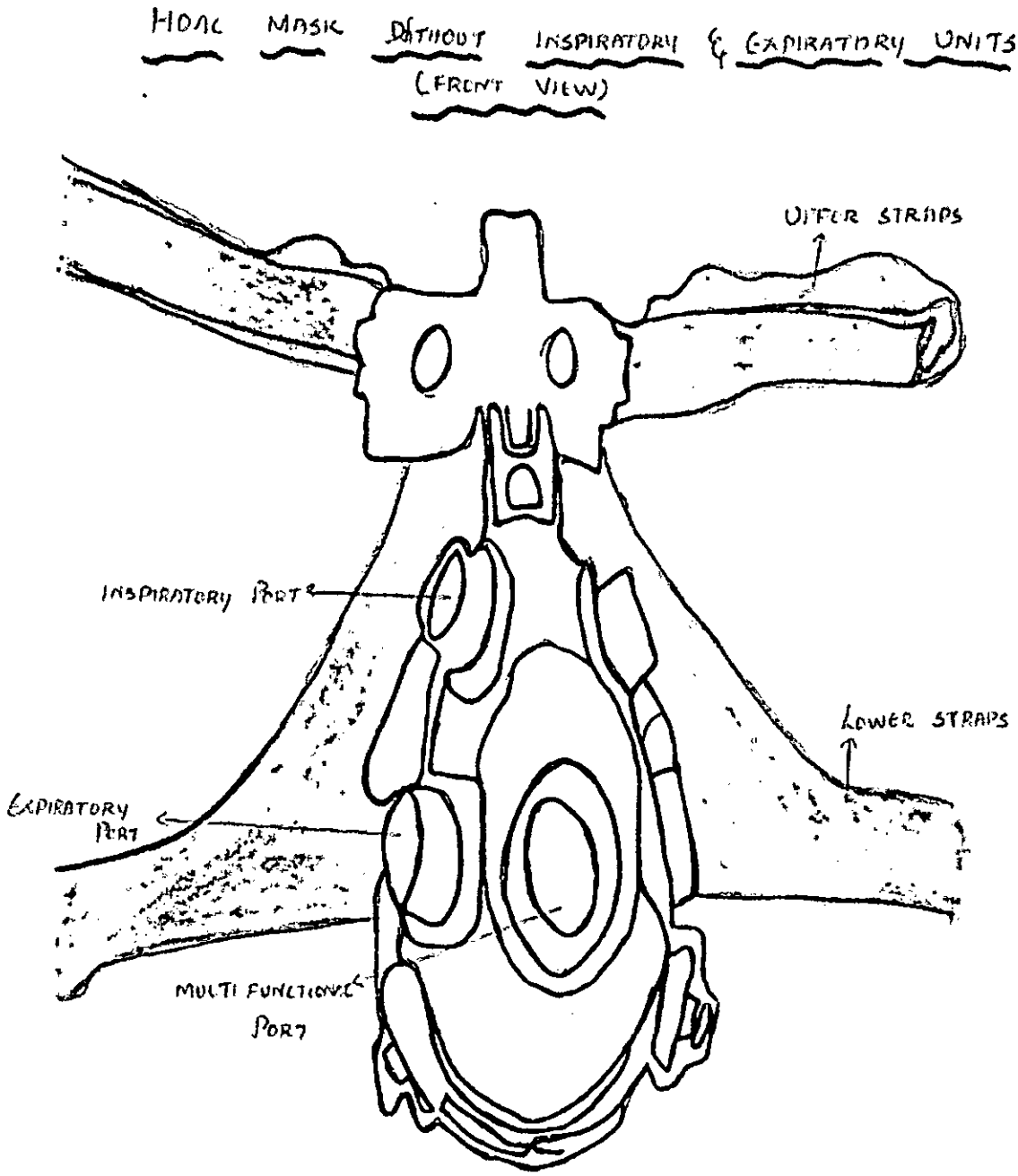

Fig 6: HOAC MASK without inspiratory and expiratory port

Multifunctional Port (concept Design)

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C.EXPIRATORY PORTS: The expiratory ports lie on the lower part of the mask and are designed for expiration. They are attached with special expiratory units as explained.

a. One-way valve: they are present at the exit point of the Expiratory ports, which allow passage of air only during expiration.

b. The bio-aerosol absorbing chamber: The chamber is made up of transparent plastic material containing an absorbent material like sponge which collects the exhaled liquid by help of condensation and gravity. This part points downwards

c. The filtering chamber: The top part of this special unit has hydrophobic filters.

d. ETCO2 Port: Above the filter there is a port to sample the expired air to assess the ETCO2

The expiratory units should be changed in case of filling up of bio-aerosol absorbing chamber.

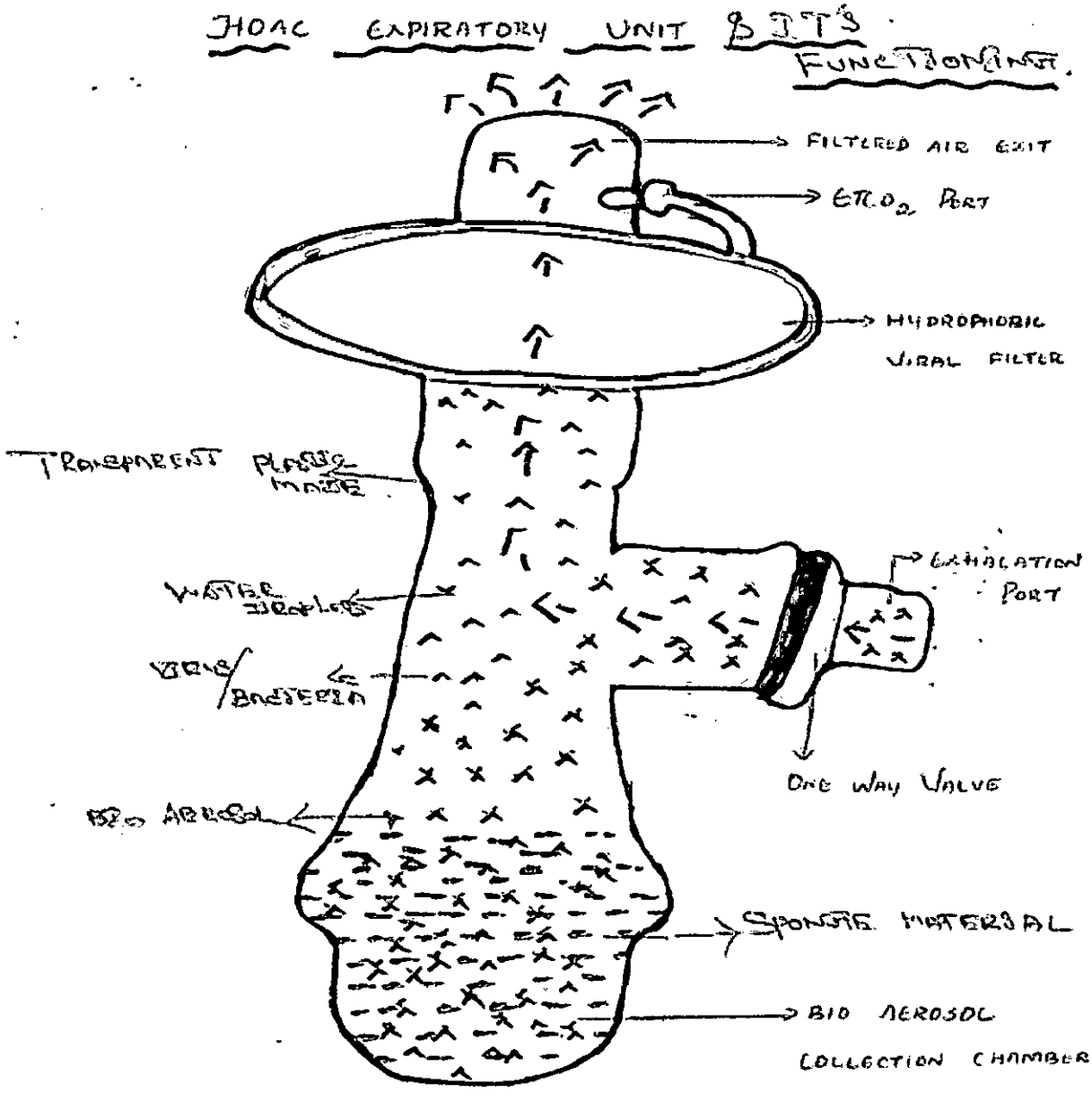

Fig 7: Expiratory Unit (Concept Design)

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PART 2) **HIGHLY OXYGENATED AEROSOL CONTROLLED MOTIVATIONAL INCENTIVE SPIROMETER(HOAC-MIS /HO-MIS)**

THIS IS LIKE A **NORMAL INCENTIVE VOLUMETRIC SPIROMETER** WITH SOME CHANGES AS FOLLOWS:

The atmospheric end is connected to non-collapsible reservoir bag. The patient mouth piece tube has one-way valve and viral filter (its adjustable in HOAC mask during spirometry to prevent accidental oral injuries by patients cough) . all the other ports are closed.
This helps in following manner:

1) It will provide filtered high concentrated oxygen from the reservoir connected to it.
2) It can be used as a completely closed system with no atmospheric interaction (With Non-Collapsing Reservoir Bag(NCRB)) or as an open system(without NCRB)
3) It has special features of

   a)Measures spo2 and heart rate(detachable finger PULSE OXIMETER)

   b)Digital thermometer for body temperature checking

   c)Reminder Alarm clock

   d)Smiley ball.

4) The measuring barrel is larger in size(Real 1000 ML/1 Lite) and thus makes accurate readings of Inhaled volume by the patients (closed system(with NCRB) and **Normal incentive spirometry reading during (open system without NCRB)**

   (volume reading upto 2000ml)

5) The pointer on the measuring barrel can be adjusted based on the patient's lung condition.

This device includes different **color** codlings based on volume.
The very Low volume (0 to 200ml) is **Black** code in closed & open (200 to 400 ml)
The Low volume (200 to 400ml) is **Red** code in closed & open(400 to 800ml)
The Average volume (400 to 800 ml) is **Yellow** code in closed & open(800 to 1600ml)
The Good volume (800 to 1000ml) is **Green** code in closed & open(1600 to 2000ml)
It indirectly shows the patient's condition.

SPIROMETER SETTINGS CRITERIA ;

It based on patient weight and lung condition:

A) **HOAC-MIS & HOMIS CLOSED SYSTEM SPIROMETER GOAL SETUP FOR LUNG DISEASE (5 to 8 ml/kg x 2/IHS IN COVID 19 AND OTHER AIR BORNE DISEASES**
B) **HO MIS /HOAC-MIS OPEN SYSTEM SPIROMETER GOAL SETUP FOR (7 to 10 ml/kg x 3 /IHS IN HEART , ABDOMEN AND OTHER PRE AND POST OPERATIVE SURGERY PATIENTS)**

Here we follow the inhalation spirometer set volume.
Example for closed system spirometer(with NCRB):
If the patient weight is 50kg than it would be
5x50x2=500ml which has to be held for some seconds at initial days.
Next day 0.5ml/kg/inspiration x2 has to be increased up to 1000ml per inspiration
Once reaching the maximum limit of 1000ml the time (in seconds) will be increased.

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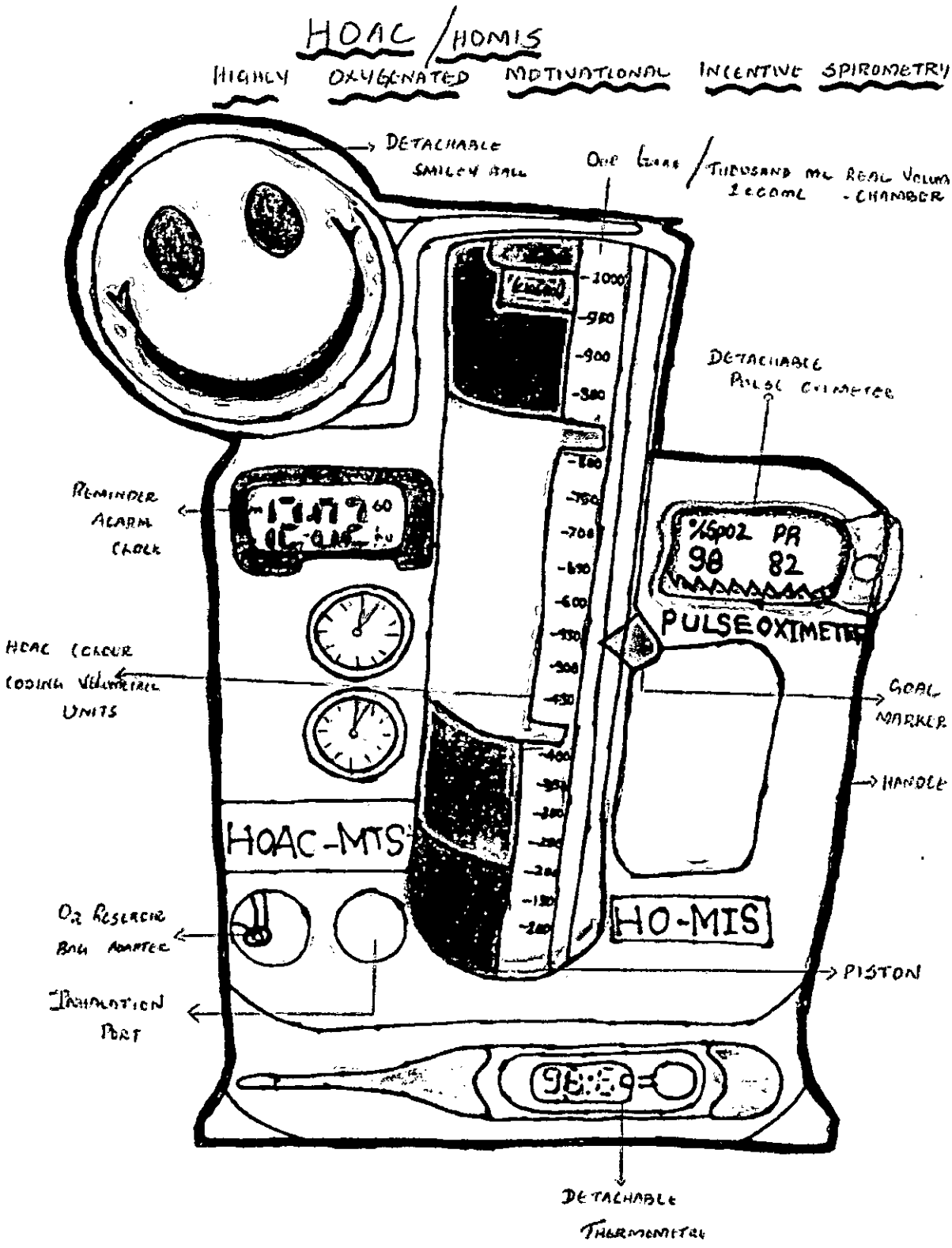

Fig 8: HOAC MIS/HO-MIS (concept design)

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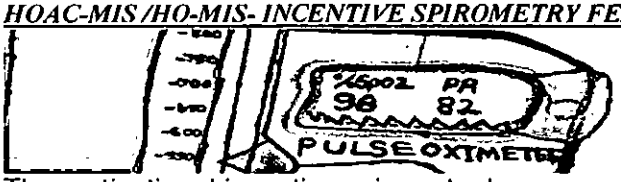
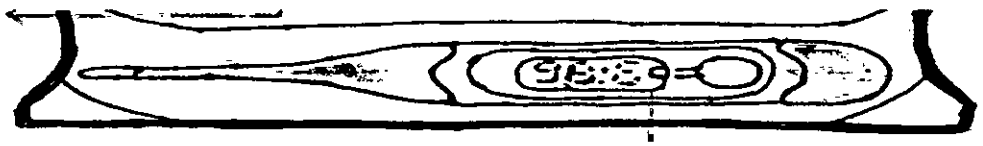
HOAC-MIS /HO-MIS- INCENTIVE SPIROMETRY FEATURES ; PULSE OXIMETER MONITORING:



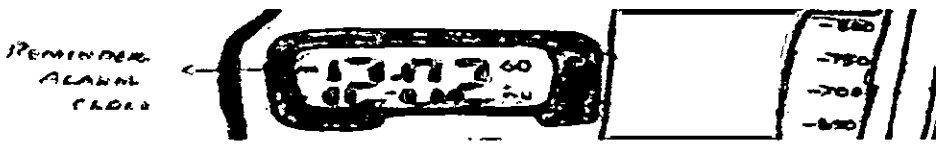
The motivational incentive spirometry has a special, detachable pulse oximeter at the left side which shows real time SPO2 during spirometry which helps to recognize the condition of the patient itself and at the same time, tachycardia can be identified by the patient or health workers to immediately stop using the device. During patient shifting and home setup also, this device can be used.

DIGITAL THERMOMETER;



The Device has an incorporated digital thermometer, which can be uses before incentive spirometry and when required

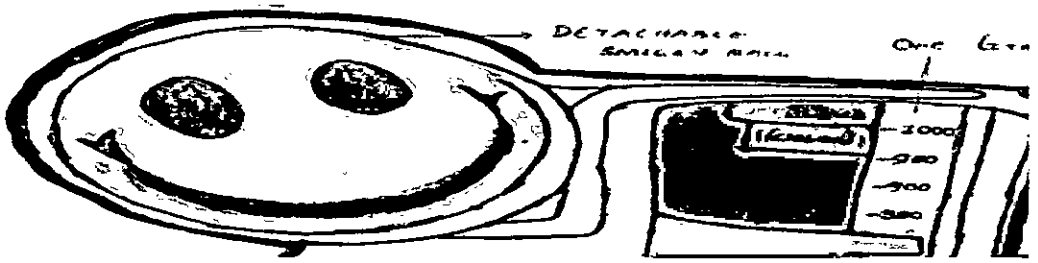
REMINDER ALARM CLOCK:



It has reminder alarm clock which is used in 3 ways which are explained as below:
Firstly, it helps to check on the spirometry inspiratory holding seconds.

Secondly, it has a facility in order to set a reminder for the next session to use the spirometry. This can be set by patients or health care workers which prevents the chances of negligence of using this device.
Thirdly, it has shows date, time, and day which will help to keep the patient oriented and reduce the chance of ICU induced delirium.

SMILEY BALL FOR STRESS REDUCING:



A smiley ball is present which helps to decrease or reduce the level of tension or stress and elevates the mood of the patient especially because of the depressing pandemic COVID-19 disease either in home or ICU setup.

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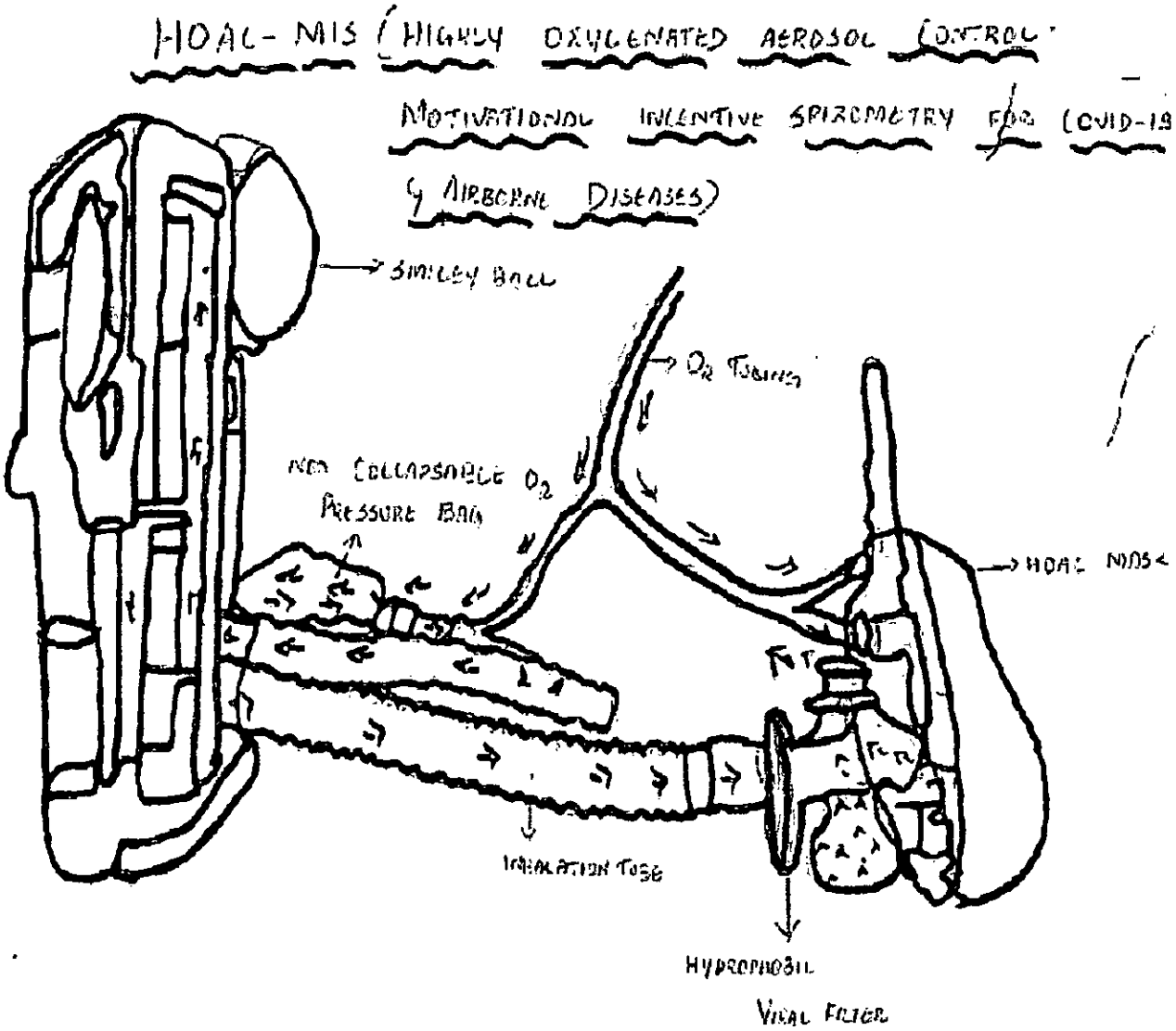

Fig 8(A): HOAC MIS (concept design)

TABLE FOR HOAC-MIS & HOMIS CLOSED SYSTEM(with NCRB) SPIROMETER GOAL SETUP FOR LUNG DISEASE (5 to 8 ml/kg x 2/IHS IN COVID 19 AND OTHER AIR BORNE DISEASES

DAY Ml/kg x2/inspiratory hold in Seconds(IHS)	DAY1	DAY 2	DAY3	DAY4	DAY5	DAY6	DAY7
	5ml/kg/IHS	5.5ml/kg/IHS	6ml/kg/IHS	6.5ml/kg/IHS	7ml/kg/IHS	7.5ml/kg/IHS	8ml/kg/IHS
Weight 70kg	700ml	770ml	840ml	910ml	980ml	1000/+IHS	1000/+HIS

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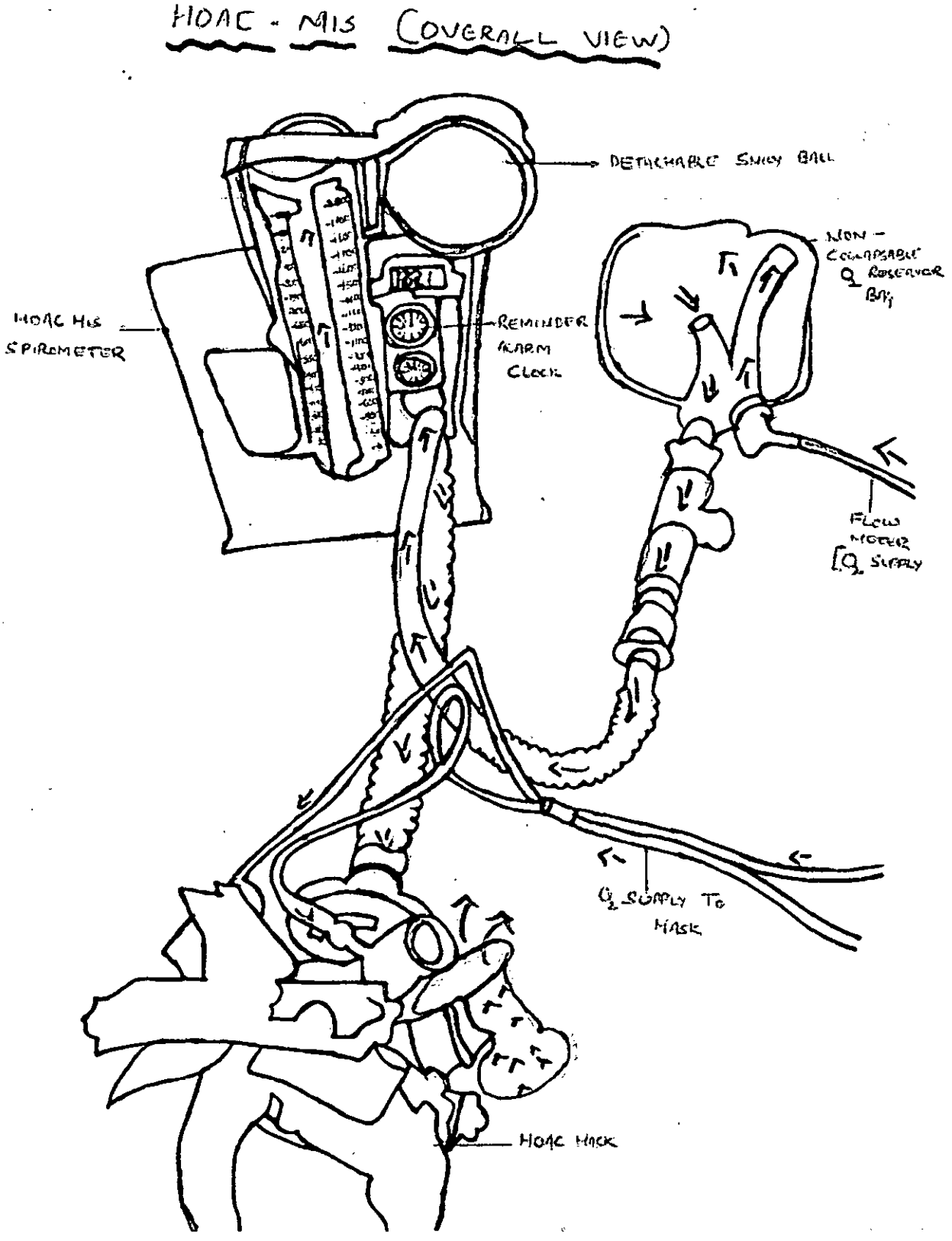

Fig 13 HOAC MIS Overall view (concept design)

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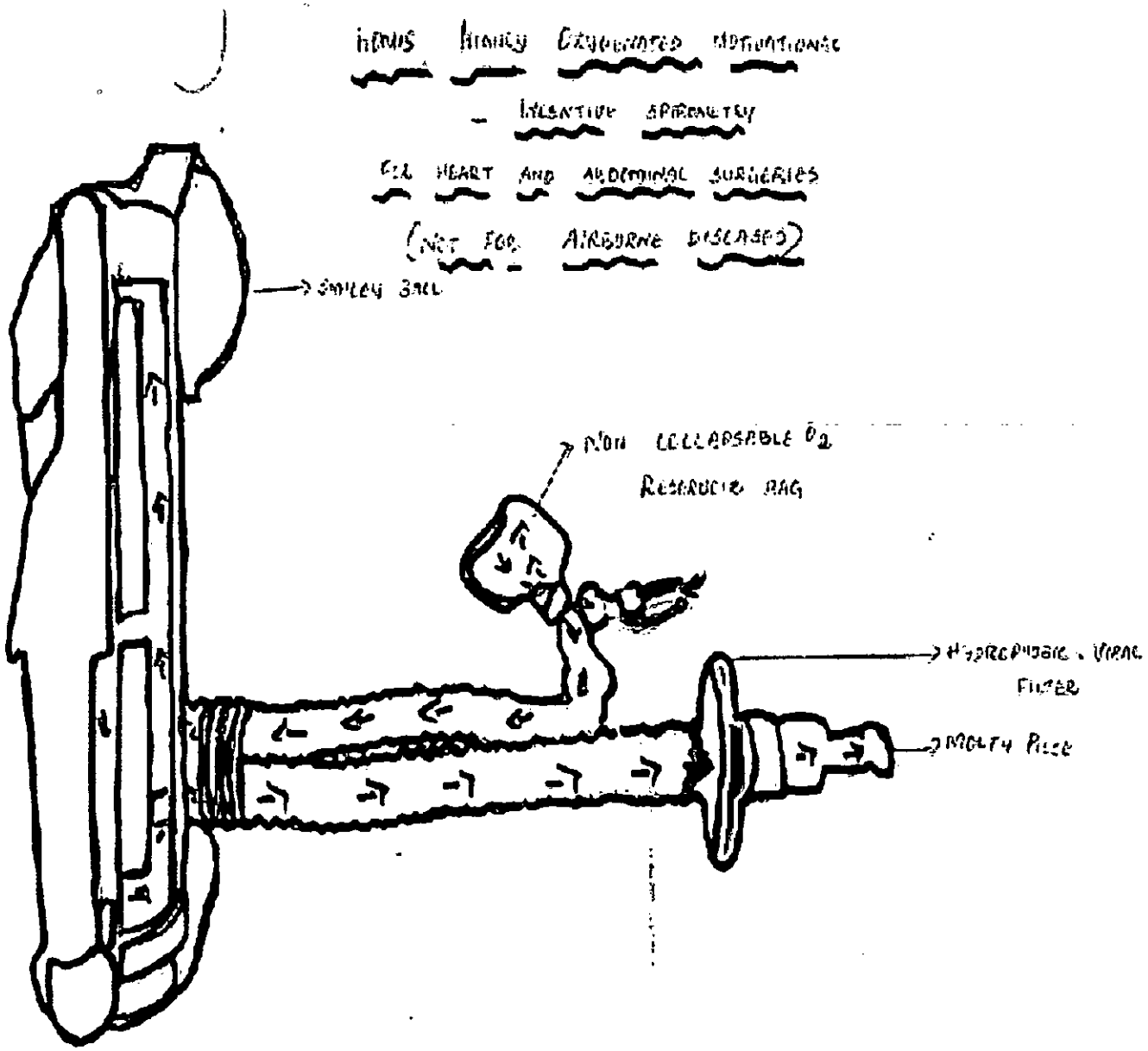

Fig 8(B): HO MIS (concept design)

TABLE FOR HO MIS /HOAC-MIS OPEN SYSTEM(without NCRB) SPIROMETER GOAL SETUP FOR (7 to 10 ml/kg x 3IHS IN HEART , ABDOMEN AND OTHER PRE AND POST OPERATIVE SURGERY PATIENTS)

DAY Ml/kgX3/ inspiratoryhol in Seconds(IHS)	DAY1	DAY 2	DAY3	DAY4	DAY5	DAY6	DAY7
	7ml/kg/I HS	7.5ml/kg/I HS	8ml/kg/I HS	8.5ml/kg/I HS	9ml/kg/I HS	9.5ml/kg/I HS	10ml/kg/I HS
Weight 60kg	1260kg	1350ml	1440ml	1530ml	1620ml	1710ml	1800ml

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PART 3) NON-COLLAPSING RESERVOIR BAG

The NCR bag comprises of double lumen flexible tubular structures- The first one is an inlet for oxygen supply and extends till middle of the bag and the second one extends till 1/3rd of the bag and connected to the inhalational port of HOAC Spirometer or the HOAC Mask with an intervening pressure releasing one-way valve.

It can provide humidified oxygen up to 15 L/min and is different from the normal reservoirs due to the following reasons:

The tubular structures are flexible and thus prevent collapse of neck and body of the bag and facilitate easy filling of the bag

The pressure releasing valve helps in preventing of false reading during spirometry and rupture of the bag

Oxygen inlet port is connected to flow meter with an intervening tri-way (the other port of the tri way is connected to inspiratory ports of HOAC mask which delivers oxygen during normal breathing)

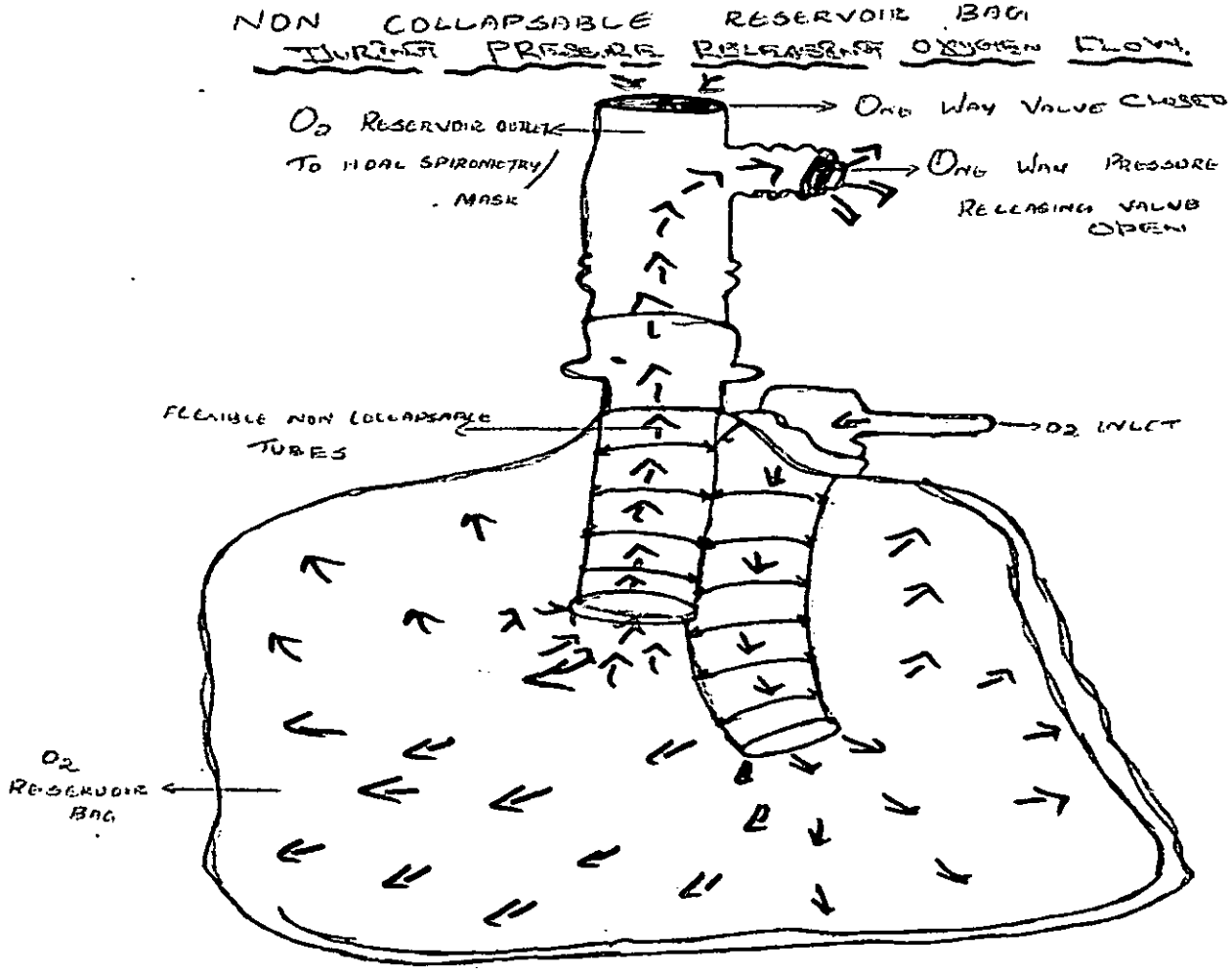

FIG 14(a): NCR Bag (concept design showing flow of oxygen during exhalation and release of the pressure through the valve)

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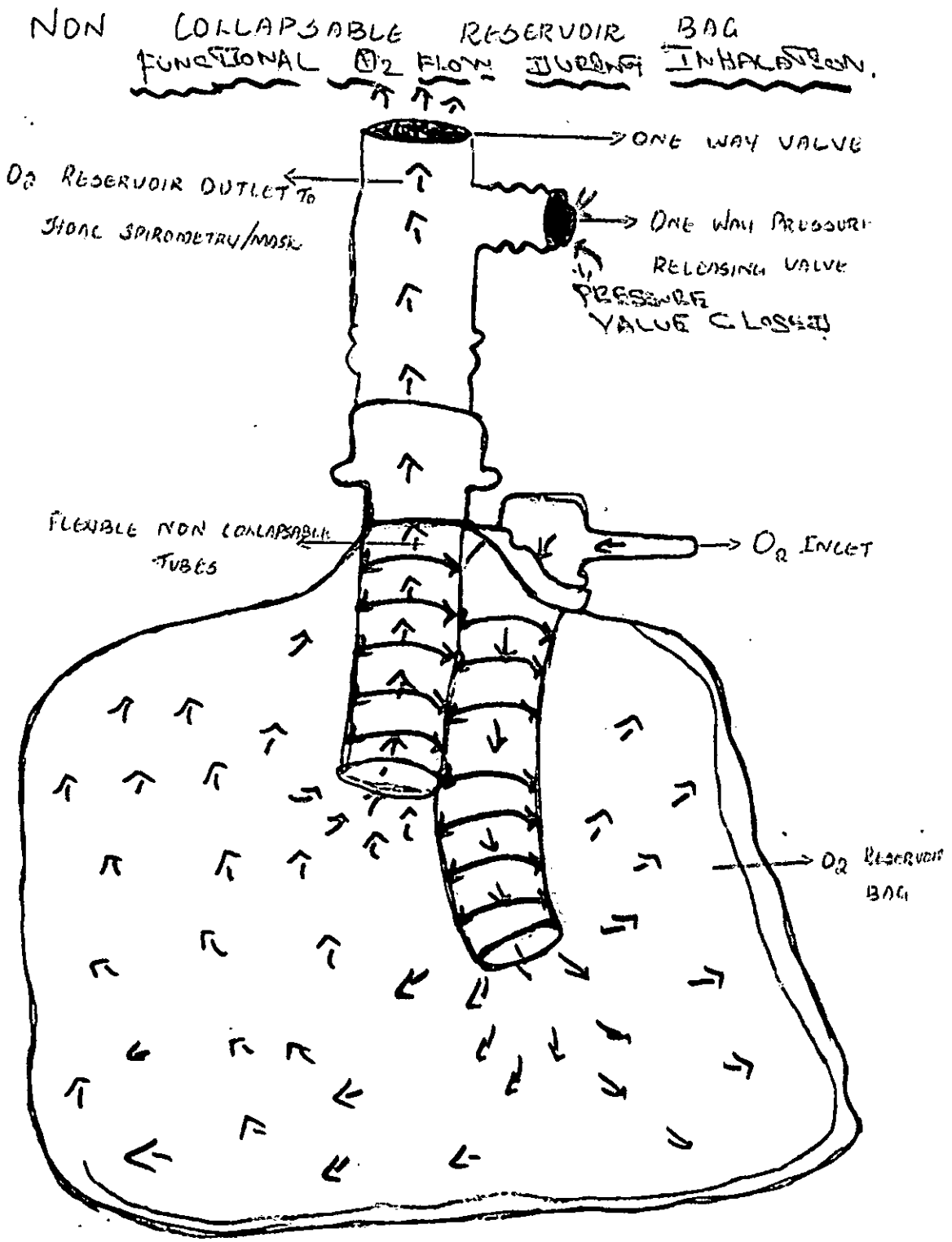

FIG 14(b): NCR Bag (concept design with flow of oxygen during inhalation)

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PART 4)ADVANCED NEBULIZATION CHAMBER

This chamber resembles the normally used chamber except as follows.

i) This is connected to the multifunctioning port of the HOAC Mask
ii) The attaching part of the unit has a one-way valve which prevents passage of aerosols into the nebulisation unit during expiration of the patient.
iii) This design also helps in saving the drug during the expiration phase of the patient.
iv) This has a small one way valve port for adding nebulisation drugs.

A protective cap is present to cover the mask end of the chamber to prevent contamination after usage.

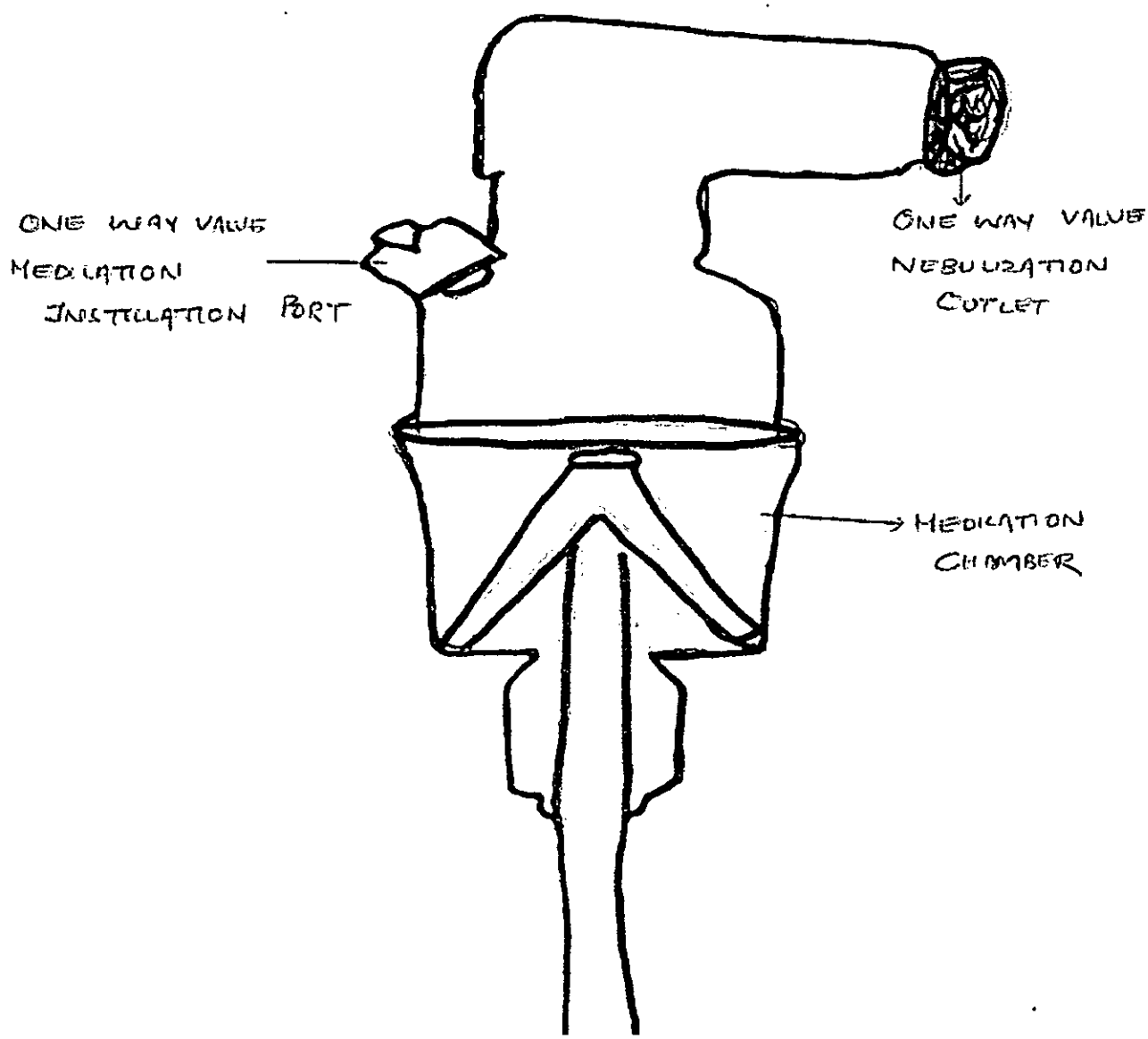

Fig 15(A) : The advanced Nebulisation unit, with one way valve (concept design)

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High Oxygenation Aerosol Controlled Nebulization (HOAC N)-

(FRONT VIEW)

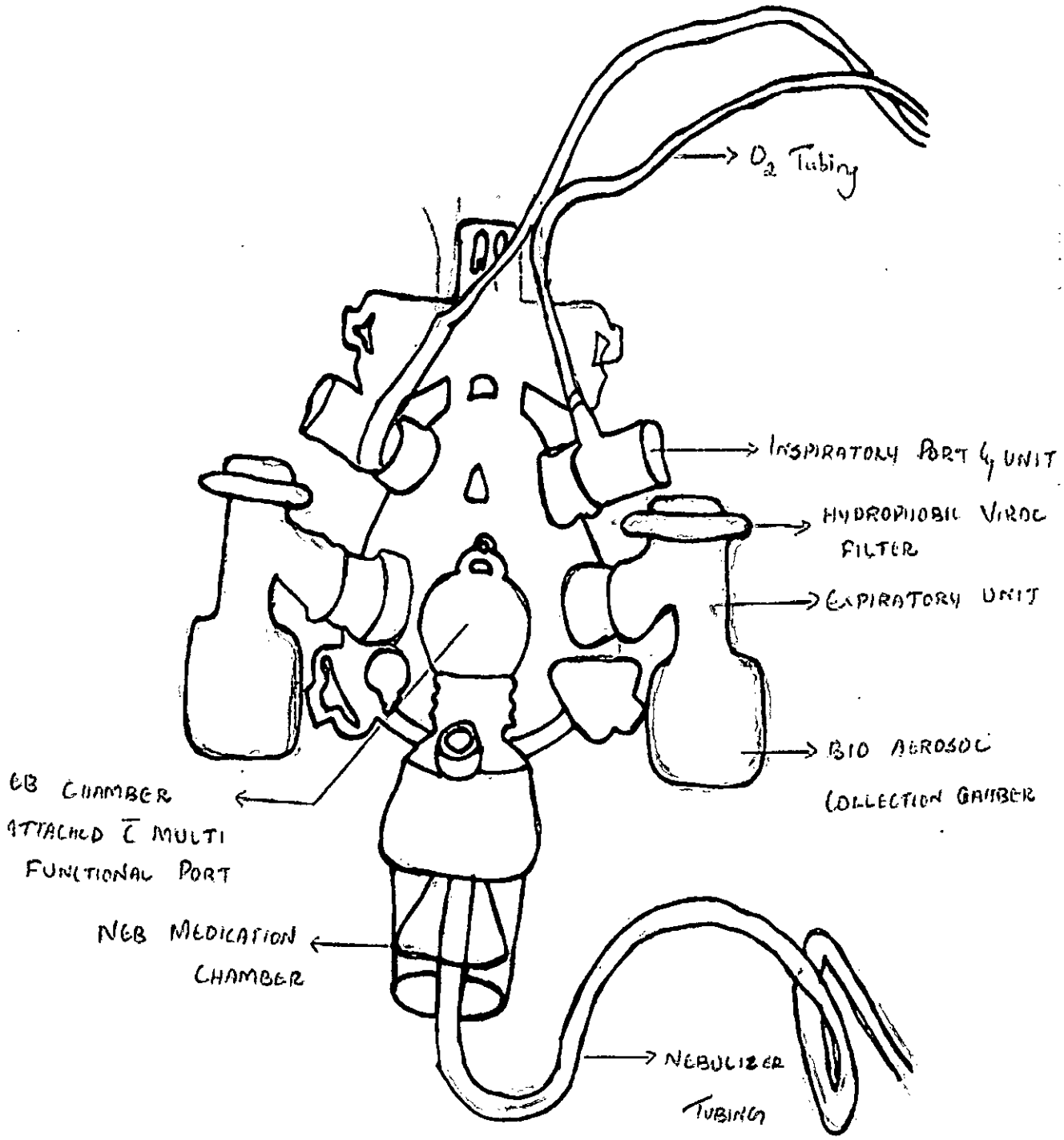

Fig 15(B):The advanced nebulization chamber attached to the Multifunction port of the HOAC Mask

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High Oxygenation Aerosol Controlled Nebulization (HOAC N)-

(PATIENTS VIEW)

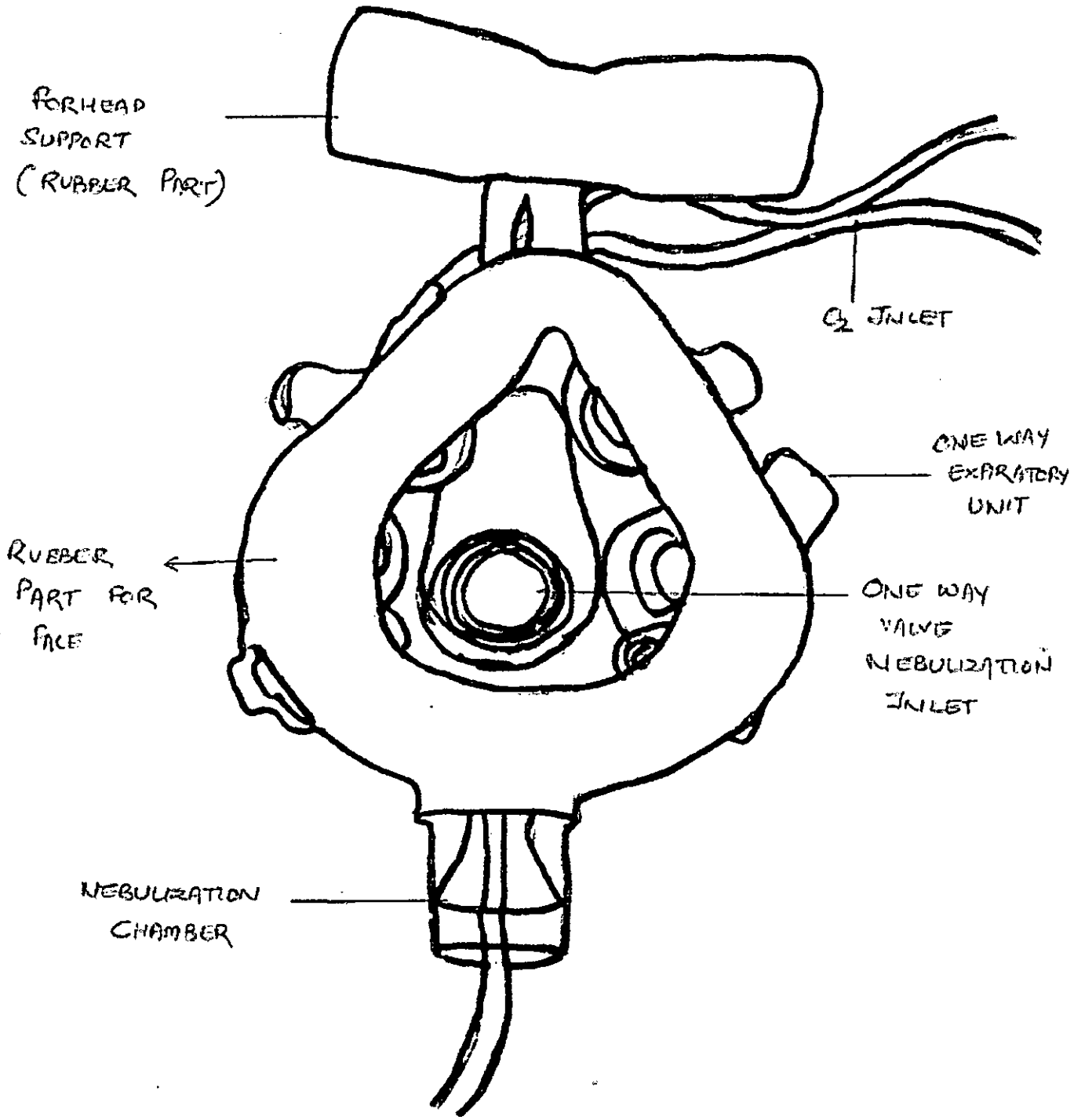

Fig 15(C): The Nebulization unit attached to the multifunction port of the HOAC Mask, as seen from patient end , The one-way valve is seen in the center

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PART 5] SPECIALIZED OXYGEN DELIVERY TUBING AND PROTECTIVE FABRIC:-

There are three tubing in all.

A. A double Y tube which delivers oxygen to both the inspiratory ports and the Nebulisation chamber/NCRB (when high level of oxygen supply is required during nebulisation or spirometry)

B. A single Y tube – to deliver Oxygen only to Inspiratory ports of HOAC Mask(when low oxygen is sufficient during nebulisation / spirometry)

C. A straight tube (connected to nebulisation chamber and nebuliser), when high oxygenation is not required during nebulisation.

D. **Protective Cloth** – to collect any sputum or aerosols if the patient coughs out after the procedure. It is made up of three-layered fabric and the central portion has an absorbing sponge like material. It can also be used to clean and sanitise the mask for reuse for the same patient

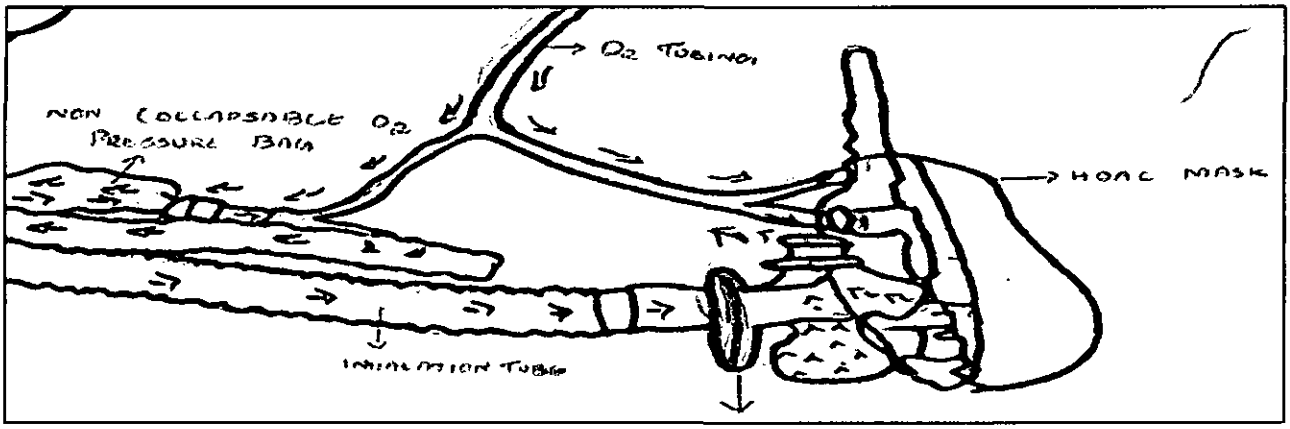

Fig 16: (a)The double - Y tube in function (concept design)

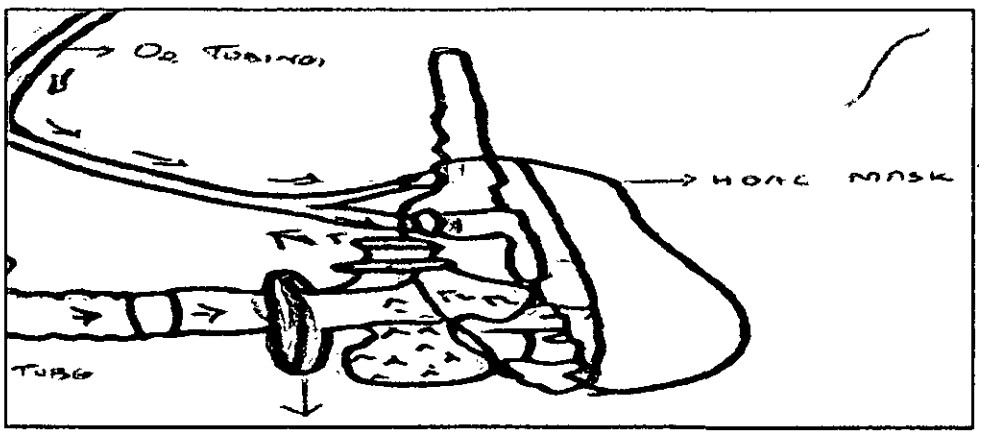

Fig 16: (b)A single - Y tube in function (concept design)

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DESCRIPTION OF 6 METHODS OF USAGE IN HOAC COMBO UNITS:

INCENTIVE VOLUMETRIC SPIROMETRY - **HOAC MIS and HO MIS**

USEAGE **1)HOAC MIS : Used when the patient has highly infectious disease like Covid -19 or other airborne diseases**

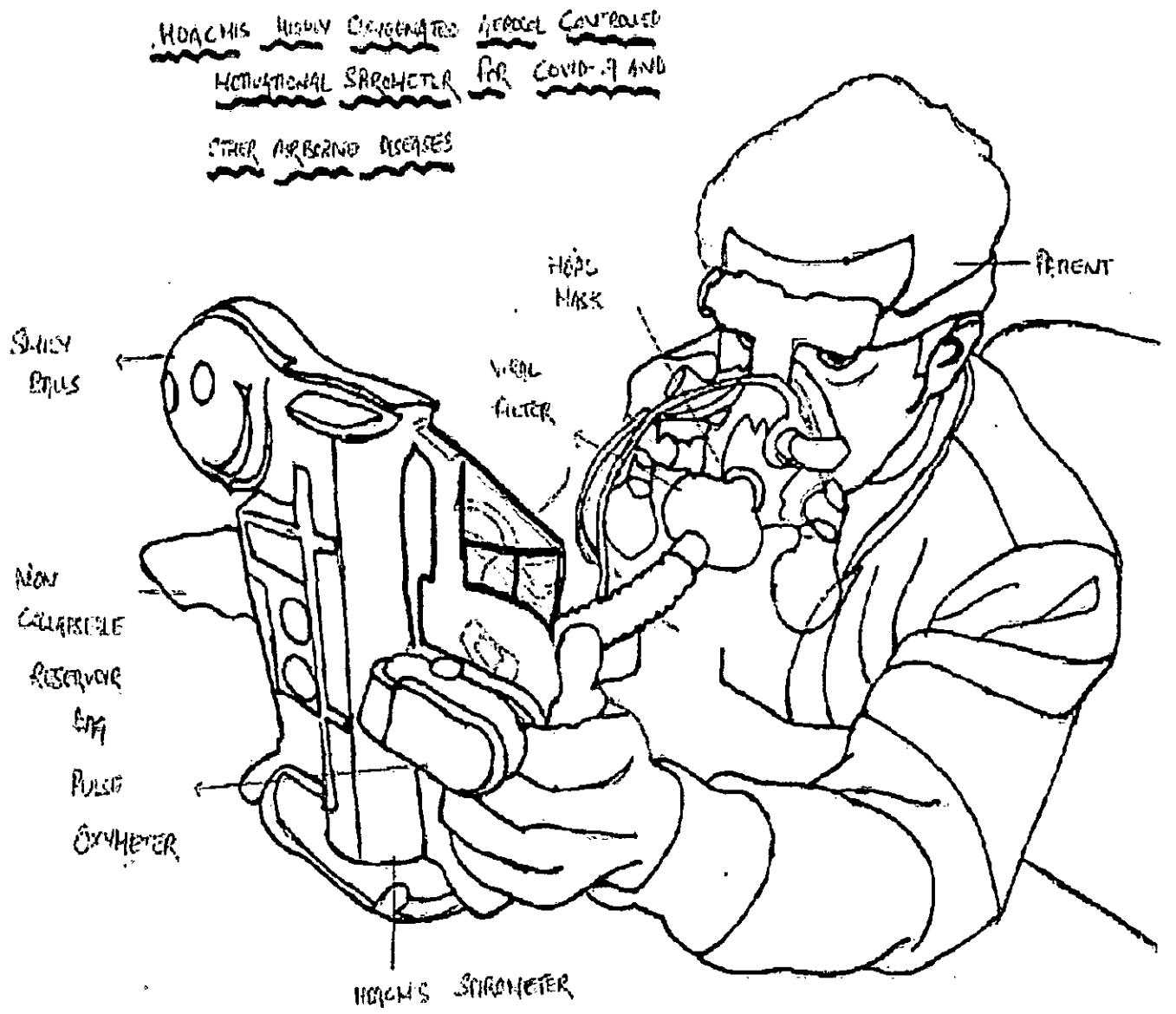

Fig 17: HOAC MIS in usage (concept design)

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USEAGE 2) HO MIS: Used when the patient does not have an Airborne infectious disease.

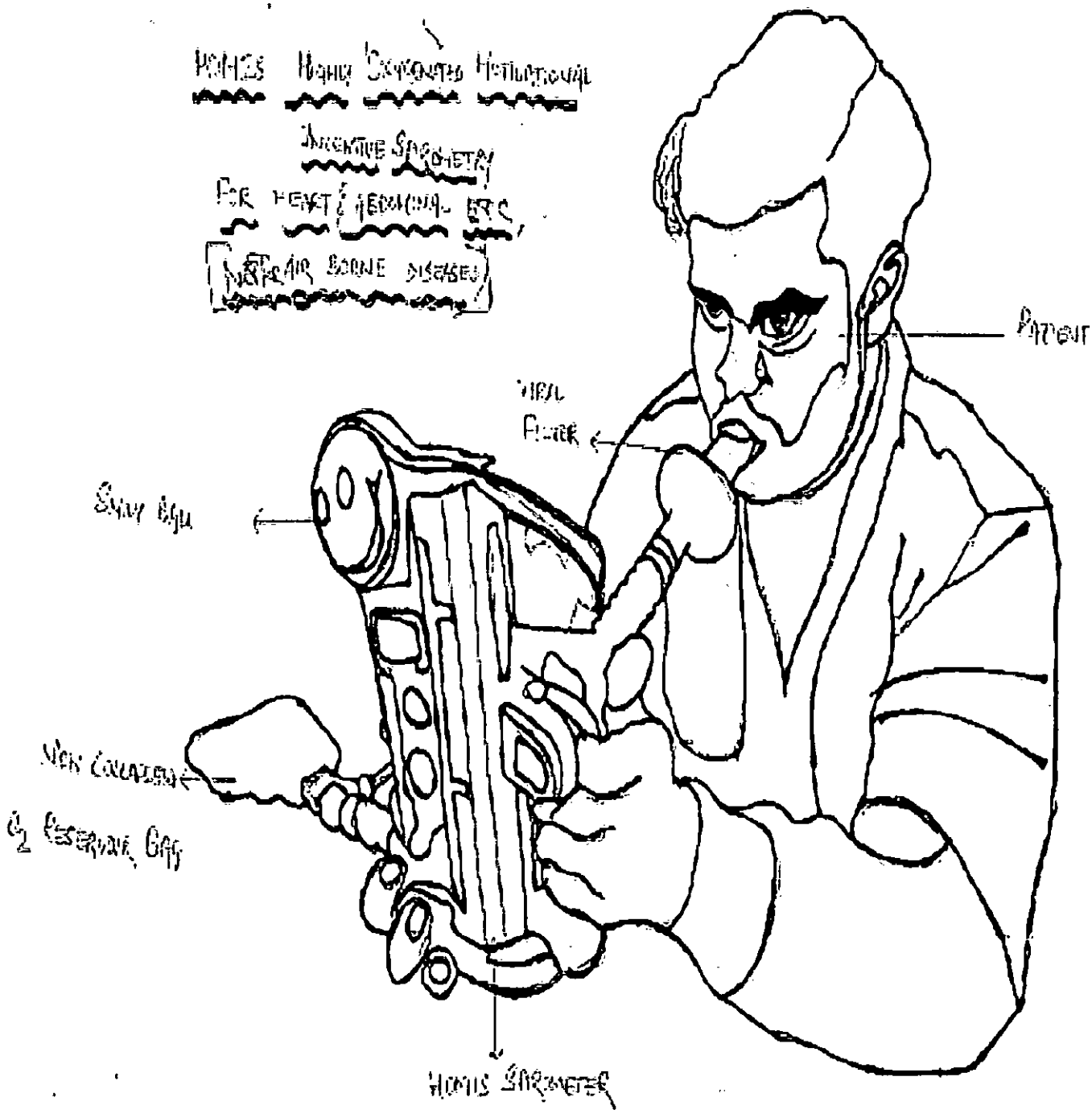

Fig 18: HO MIS is usage (Concept design)

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HOAC-MIS AND HO-MIS PROCEDURES STEPS;

Incentive spirometry Procedure steps (Spirometry should not be done when the patient has fever And extrium heart rate which can be checked with provided digital thermometer and pulse oximeter)

1) SPIROMETRY WITH HIGH OXYGEN REQUIREMENT:

HOAC MIS (closed system - usage with NCR bag)

a) connect the inflow end of double Y tube to the oxygen flowmeter and single outflow connected to oxygenation port of NCRB and double outflow connected to inspiratory ports of the HOAC mask

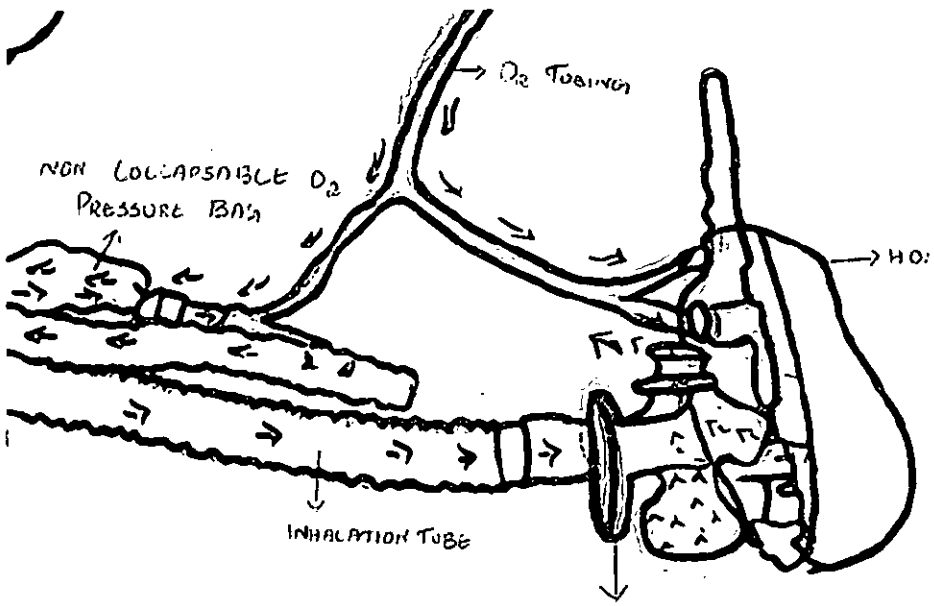

Fig 19

b) then attach NCRB's outlet to HOAC Spirometer's airflow inlet and spirometry mouthpiece attached to the multifunctional port of HOAC mask.

c) Start the high oxygen flow as required.

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2) SPIROMETRY WITH LOW OXYGEN REQUIREMENT; HOAC MIS (Open System - No NCR Bag attached)

A. Connect a double Y tube's inflow end to the flowmeter, single outflow connected to the oxygen port of spirometry and double outflow in the HOAC Mask's inspiratory oxygen inlet.

B. Attach the HOAC mask to the patient and secure it with straps. Ascertain good sealing around nose and mouth of the patient.

Rest of the steps are usually the same as normal incentive spirometry. The SPO2 and Heart rate should be monitored during the procedure

At the end of the HOAC MIS procedure, the patient should take some normal breaths before disconnecting the mask (unless emergency) to minimize the spread of pathogens in the mask.

After the procedure is completed the straps should be loosened, oxygen flow should be reduced and then the mask can disconnect completely from the patient.

The protective cloth can be used for sanitizing the mask and also to cover the patient's mouth in case of coughing.

At last the spirometry's mouthpiece and mask should be capped and kept away for further usage. The reminder Alarm should be set for next usage.

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Differences between HOAC MIS ,HOMIS Incentive Spirometry and Normal Incentive Spirometry

Feature	**HOAC MIS SPIROMETRY**	NORMAL INCENTIVE SPIROMETRY	**HO MIS**
Applicability	Covid-19 and other droplet and airborne diseases (suspects And Positive)	Only in diseases without droplet or Airborne spread (only for Normal patients)	Only in diseases without droplet or Airborne spread(only for Normal patients) post recorverd Covid-19 and other droplet and airborne diseases
Special features	Measures spo2 and heart rate ,digital thermometer, Reminder alarm clock Smiley ball for stress buster	Not available in normal spirometer	Measures spo2 and heart rate ,digital thermometer, Reminder alarm clock Smiley ball for stress buster
Benefit 1	Useful as Aerosol controlling system where the disease spread is inhibited	Aerosols are not controlled; hence disease spread is possible	Aerosols are not controlled; hence disease spread is possible
Benefit 2	The system prevents catching disease from the atmosphere	The patient is exposed and can acquire disease from others	The system prevents catching disease from the atmosphere
Benefit 3	Can be used with high flow and low flow	Can be used only with low flow and without oxygen requirement	Can be used with high flow (nasal prongs for patient, and straight tube between flowmeter and NCR Bag) low flow (straight tube between flowmeter and Oxygen port of Spirometer) and without Oxygen flow as per the requirement
Benefit 4	100% oxygen FIO2 can possibile during spirometry inhalation phase	100% FIO2 is not possible	100% oxygen FIO2 can possible during spirometry inhalation phase
Benefit 5	ETCO2 can monitored during spirometry	Cannot be monitored	Cannot be monitored
Benefit 6	The Chamber is big in size and shows the actual inhaled volume. This also has the reading of a normal Spirometer (when open system is used)	It does not show the actual inhaled volume.	The Chamber is big in size and shows the actual inhaled volume. This also has the reading of a normal Spirometer (when open system is used)
Benefit 7	Color coding system to indirectly show the patient condition to health	There is no such feature	Color coding system to indirectly show the patient condition to health professionals and motivate the

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	professionals and motivate the patient.		patient.
Drawback	The device has to be attached tightly for good efficacy, and cannot be used in patients with facial trauma or in children.		

USEAGE 3)AEROSOL CONTROLLED HIGHLY OXYGENATED NEBULIZATION (HOAC-N)
PROCEDURE STEPS:

1) NEBULIZATION WITH HIGH OXYGEN REQUIREMENT;
connect the inflow end of double Y tube to the oxygen flowmeter and single outflow connected to Modified nebulization chamber inlet and double outflow connected to inspiratory of HOAC mask.

2)NEBULIZATION WITH LOW OXYGEN REQUIREMENT;
Connect a single Y tube's inflow end to the flowmeter and double tube outflow in the HOAC Mask's inspiratory ports and the straight tube is connected to nebulisation chamber and nebuliser machine.

Attach the HOAC mask to the patient and secure it with straps. Ascertain good sealing around nose and mouth of the patient.

Instil the drugs through the one valve drug port of the nebulization chamber

start oxygen flowmeter/Nebuliser as required.

Rest of the steps of Nebulisation are similar to the usual procedure

At the end of HOAC Nebulisation procedure, the patient should take some normal breaths before disconnecting the mask (unless emergency) to minimise the spread of pathogens in mask.
After the procedure is completed the straps should be loosened, oxygen flow should be reduced (or nebuliser is stopped) and then mask can disconnect completely from the patient.
The protective cloth can be used for sanitizing the mask and also to covers the patient's mouth in case of coughing.
At last the nebuliser's open end and mask should be capped and kept away for further usage.

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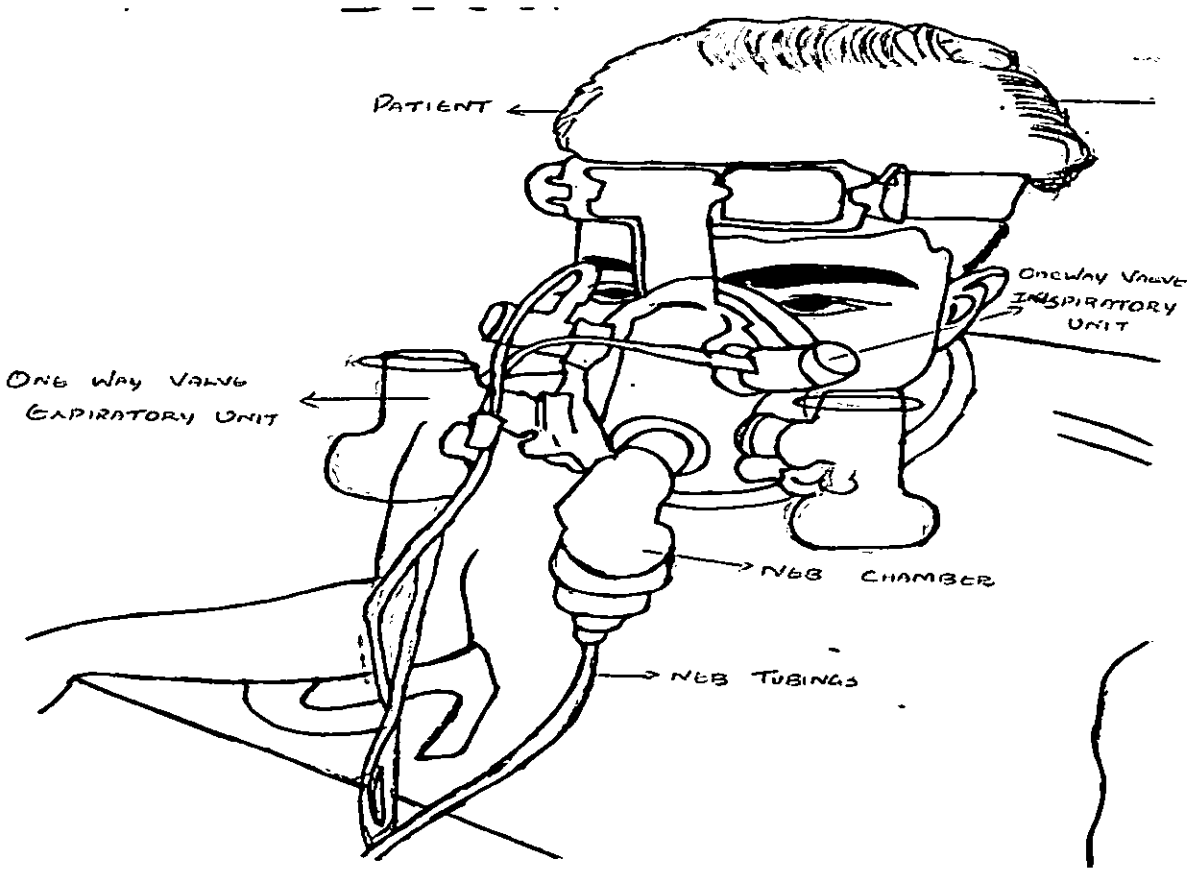

Fig 20: HOAC Nebulisation in use (Concept Design)

Difference between HOAC Nebulisation and Normal Nebulisation

Feature	HOAC NEBULIZATION MASK	NORMAL NEBULIZATION MASK
Aerosol Control	Aerosols are controlled	Not controlled
Uses	Suspects and Positive (covid19 & airborne diseases etc..)	Only for Normal patients
Oxygen supplementation	Can be used in patients requiring, high and low oxygen supply	Can be used only in patients requiring low and no oxygen supply
Drug loss	The nebuliser drug is not lost to the atmosphere	A lot of drug is lost during the procedure
Contamination	One-way drug instilling port prevents contamination from healthcare workers	Contamination possible
Chamber Contamination	The expired air does not reach the nebulisation chamber; therefore, the chamber is not contaminated	Possibility of the chamber contamination is present
ETCO2 Measurement	Possible during the procedure	Not Possible

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USEAGE 4; AEROSOL CONTROL NON-RE-BREATHER MASK (ACNRBM) FOR SHIFTING OF PATIENTS WITH COVID 19 AND AIRBORNE DISEASES

When a symptomatic patient with Covid 19 or any other airborne diseases who is on Face mask support, needs to be shifted from one hospital to another hospital or from one ward to another ward of the same hospital, ACNRBM should be attached.

CONNECTIONS

a. Connect the inflow end of double Y tube to the oxygen flowmeter in portable oxygen cylinder and single outflow end is connected to oxygen port of NCRB and double outflow end is connected to inspiratory ports of HOAC mask

b) then attach NCRB with viral filter to multifunctional port of HOAC mask

c) Start the high oxygen flow as required.

d) Attach the HOAC mask to the patient and secure it with straps. Ascertain good sealing around nose and mouth of the patient.

e) now the patient is ready for shifting in respective receiving hospitals or ward/ ICU

f) After the shifting is completed the straps should be loosened, oxygen flow should be reduced and then the mask can disconnect completely from the patient and a normal face mask can be attached.

Difference between ACNRBM and Normal FACE MASK during shifting;

Feature	AC NRBM	SIMPLE OXYGEN FACE MASK
Uses	Specialised for Symptomatic Covid – 19 and other airborne and droplet spreading disease	Only for low infectivity patients
Uses	Suspects and Positive	Only for low infectivity patients
During Shifting	This prevents spread of aerosols	Does not prevent the spread
Structure	Prevents twisting/kinking of the neck and collapse of bag	Not applicable
Structure	The oxygen inlet to bag and outlet towards patient are different	Not applicable
Structure	Prevents the direct spillage on face	
Oxygen failure	The patient can breathe even if the oxygen supply is stopped	The patient can breathe even if the oxygen supply is stopped

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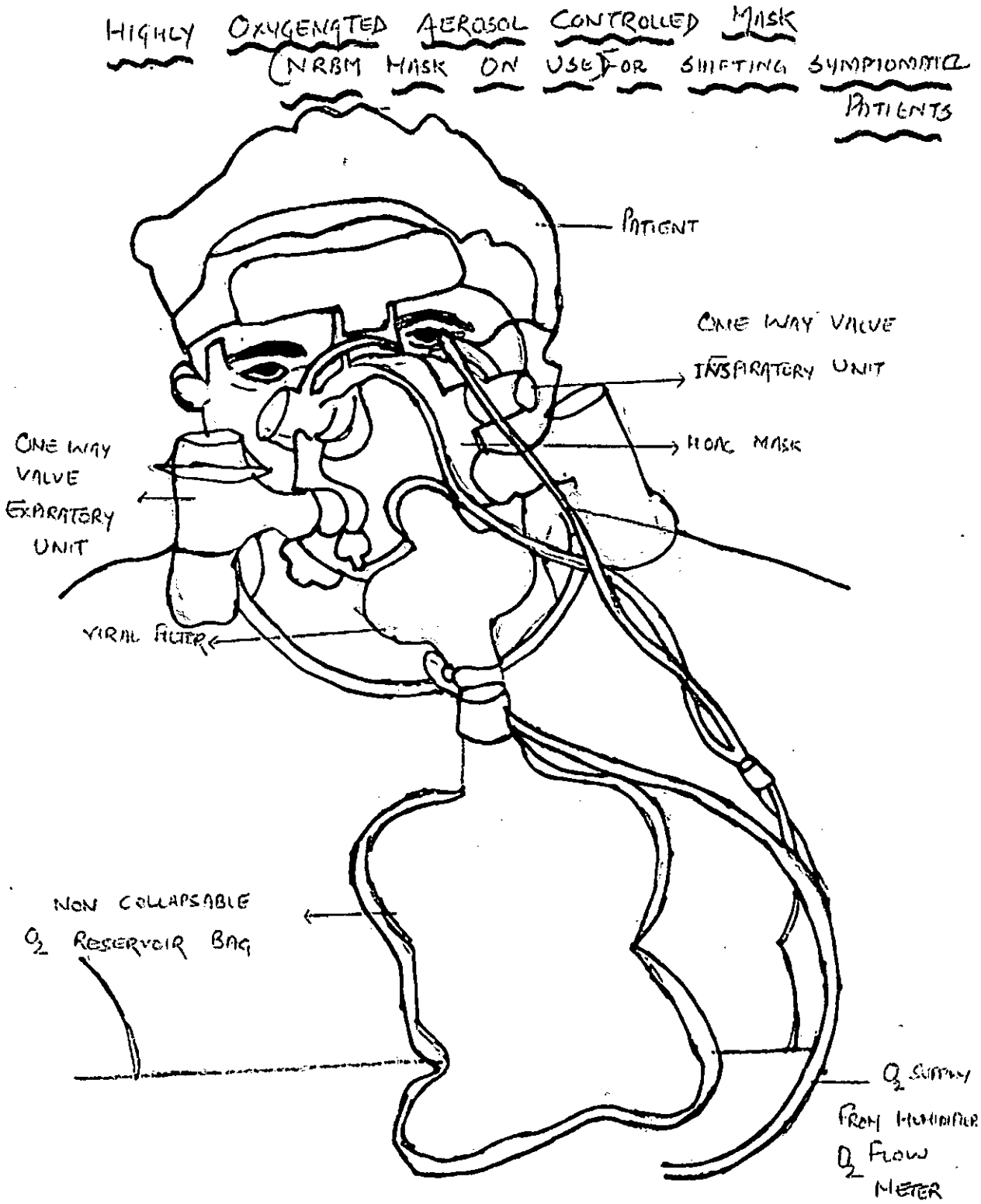

Fig 21 AC NRBM in use during shifting of patient usually on Face mask (Concept design)

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USEAGE 5; AEROSOL CONTROL FACE MASK (ACFM) FOR SHIFTING OF PATIENTS WITH COVID 19 AND AIRBORNE DISEASES

When a patient with Covid 19 or any other airborne disease who needs the support of Nasal prongs has to be shifted from one hospital to another or from one ward to another of the same hospital, a viral filtered oxygen inlet is attached to the multi-functional port of the same structure. And then it acts as an aerosol control FM.

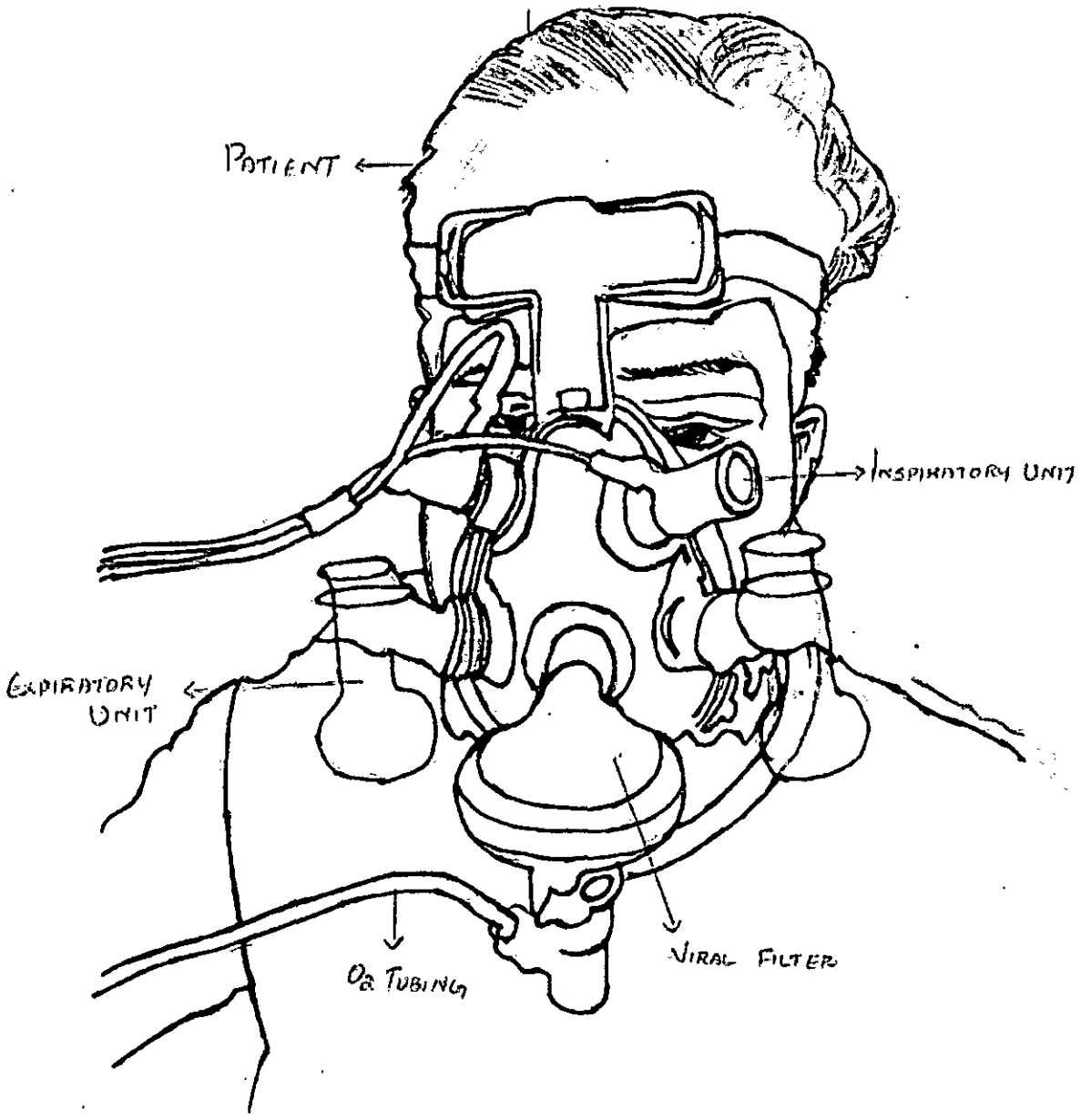

Fig 22: AC Face Mask usage (for shifting symptomatic patients on Room air or Nasal prongs)

(concept design)

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AC-FM CONNECTIONS;

a) connect the inflow end of double Y tube to the oxygen flowmeter in portable oxygen cylinder and single outflow connected to viral filtered oxygen inlet in multifunctional port of HOAC mask and double outflow connected to inspiratory of HOAC mask
c) Start the oxygen flow as required.

d) Attach the HOAC mask to the patient and secure it with straps. Ascertain good sealing around nose and mouth of the patient.

E) now the patient ready for shifting in respective receiving hospitals or ward/ ICU

F) After the shifting is completed the straps should be loosen, oxygen flow should be reduced and then the mask can disconnect completely from the patients and immediately attached to the nasal prongs

Difference Between AC Face Mask and Nasal prongs During shifting;

Feature	AC NRBM	NASAL CANNULA/ NASAL PRONGS
Uses	Specialised for Symptomatic Covid – 19 and other airborne and droplet spreading disease	Only for low infectivity patients
Uses	Suspects and Positive	Not applicable
During Shifting	This prevents spread of **Aerosols**	Does not prevent the spread

USEAGE 6 NON-INVASIVE VENTILATION MASK;

If the patient is not maintaining oxygen saturation with FM or NRBM and requires Non-Invasive Ventilation Mask (NIVM), the same design serves the purpose. Remove the two inlets, two outlets and close it tightly with appropriately sized caps and then it is ready to act as a NIV mask.

If the patients got negative from covid19 and other airborne diseases mean

The mask,incentive spirometer, nebulization chamber and the oxygen reservoir and tubing can be reused after removing the viral filter and Ethylene Oxide (ETO) sterilization for the same patient. So here advantages HOAC COMO can be used for susceptive, positive and post negative with or without oxygen and home isolating and treatment patients.

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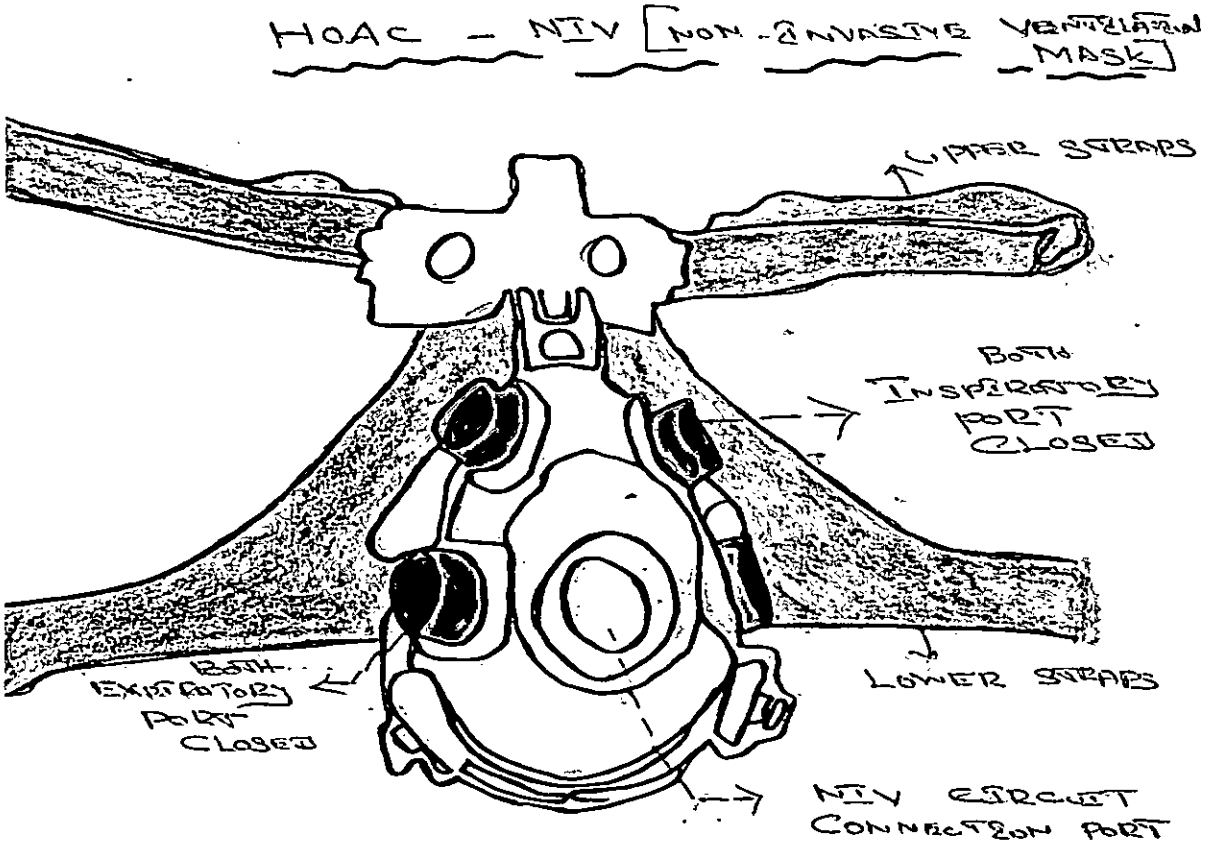

Fig 23: NIV MASK USAGE (concept design)

CONCLUSION ;

The HOAC device allows for nebulization of patients of Covid 19 and other airborne diseases ,also allows incentive spirometry with oxygenated air, without producing any aerosols ,this also prevent or slow down the progression of the disease from mild to moderate stage or from moderate to severe stage of the COVID-19 And Airborne diseases and ultimately reduce the incidence of spread of covid-19 and Air borne disease from a known patient to other patients and to health care workers by reduction of aerosol production.so, It will directly help to reduce mortality rate of pandemic diseases.

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26/3/21

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