Corning 965 Carbon Dioxide Analyzer Instruction Manual

Repairs advice: 1-800-263-3559

Ref. No. 965.91.9015

IMPORTANT

Dear Customer,

Congratulations on choosing your new instrument from the Corning range.

Please note that when ordering accessories and spare parts for your instrument, or requesting service, it is important to supply the following information:

- a full description of the required item and its catalogue number.
- the model number of the instrument.
- the serial number of the instrument.

The serial number will be found on the instrument rear panel.

By letting us have this information you will help to ensure that you receive the correct item with the minimum of delay.

WARNING

VOLTAGES DANGEROUS TO HUMAN LIFE ARE PRESENT IN THIS INSTRUMENT. WHEN MAKING INTERNAL ADJUSTMENTS WITH THE POWER CONNECTED EXERCISE EXTREME CAUTION.

Contents

Section 1
Introduction

1.1 Introduction

The 965 Carbon Dioxide Analyzer provides in one module, a system for the routine estimation of carbon dioxide in serum or plasma. A short time spent in familiarizing yourself with this manual will ensure the accuracy of the results.

1.2 Principle of Operation

The estimation of the amount of carbon dioxide in liquids by initially releasing the carbon dioxide gas through reaction with acid, has been used in most established methods for more than 50 years (Ref.1). Various techniques have been used to measure the released carbon dioxide gas, for example, manometrically, volumetrically (Ref.1) colorimetrically (Ref.2) or by gas chromatography (Ref.3).

The 965 uses the release of carbon dioxide by reaction with a reagent containing lactic acid (CO_2 reagent) and measures the released carbon dioxide concentration by means of a thermal conductivity detector.

Speed and precision are achieved by a combination of the automation of the gas release and measurement procedures, together with the geometry of the reaction chamber and composition of the CO_2 reagent.

Between 50 and 100 microlitres of sample (plasma, serum, or standard) are pipetted into the sealed reaction chamber which contains a small amount of the CO_2 reagent. The sample and reagent are then mixed together by means of a stirrer within the reaction chamber, with the result that bicarbonate and carbon dioxide gas dissolved in the sample are released into the reaction chamber air space as carbon dioxide.

Air containing the released carbon dioxide is then transferred to the thermal conductivity detector by pumping a fixed volume of the CO_2 reagent into the reaction chamber. The change in thermal conductivity within the detection chamber is proportional to the CO_2 content of the gas volume transferred and is measured by a bridge circuit using a closed loop reference cell containing ambient air.

The 965 instrument is zeroed by using the CO_2 reagent.
Calibration is achieved by pipetting into the reaction chamber an aqueous standard solution.

1.3 Summary of Performance Characteristics

Precision
See Appendix C.

Relative Accuracy

No significant bias (paired 'T' test) against reference method (Van Slyke).

General

Sample requirement
50 to 100 microlitres of serum or plasma.

Speed of analysis
Approximately 36 seconds per sample, at 50Hz. This is a maximum, on 60Hz each analysis will be completed in approximately 30 seconds.

Readout
Digital LED 3½ digit, seven segment display bi-polar.

Printer Interface
Customer option BCD, at time of purchase, not retrofittable.

Section 1
Introduction

1.1 Introduction

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Section 1
Introduction

Range
Up to 60 mmol/l

Warm up
24 hour operation recommended.

15 minutes warm up is necessary for the 965 to meet the stated specification.

Operating environment
Temperature 10°C to 35°C
Relative humidity 85% at 27°C.

Electrical supply
The 965 is supplied for operation on
100V ± 10%, 50–60 Hz
115V ± 10%, 50–60 Hz
200V ± 10%, 50–60 Hz
220V ± 10%, 50–60 Hz
240V ± 10%, 50–60 Hz.

Power rating
120 VA (60 Hz)
150 VA (50 Hz)

Fuse rating
All instruments 2 A anti-surge

Size
233 mm (9.2") high x 327 mm (12.9") wide x 335 mm (13.2") deep

Weight
9 kg (20 lbs).

Section 2
Installation

2.1 Unpacking and Assembly

When the 965 is received, it should be removed from the carton and inspected for damage. In addition to the instrument, the carton also contains an Accessory Kit and Unpacking Instructions. Carry out the assembly instructions detailed in the Unpacking Instructions.

CAUTION If the 965 is to be transported, refer to Appendix G and carry out the Draining and Packing procedure.

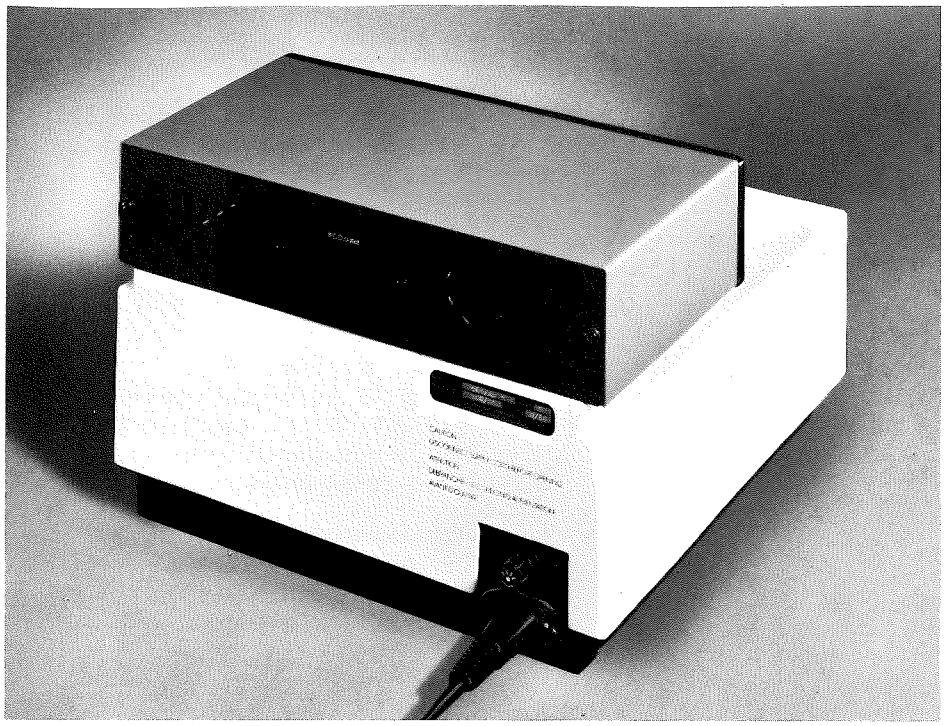

Figure 2.1 Rear Panel with Power Lead

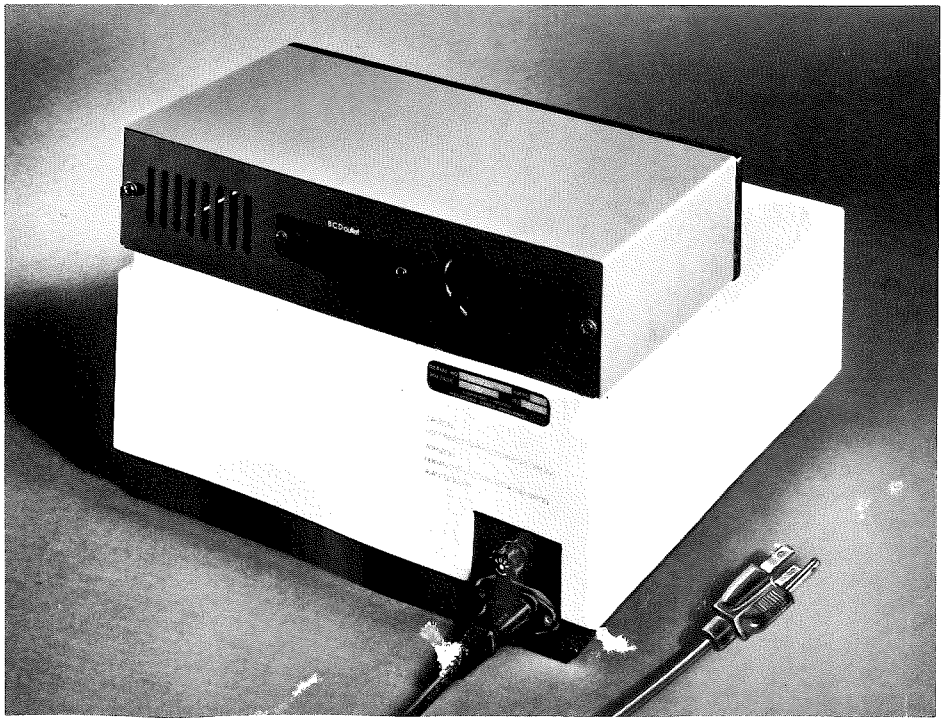

Figure 2.2 Rear Panel with Line Cord

Section 2
Installation

2.2 Services Required

The only service required is an electrical supply corresponding to the operating voltage of the 965 (100, 115, 200, 220, 240V ± 10% 50–60 Hz).

The operating voltage of the 965 is shown on the voltage warning label. The a.c. socket must be within 2 metres (6 feet) of the 965 operating position.

2.3 User Controls and Displays

NOTE For clarity when describing the 965 operating sequence the following descriptions are used:

Analysis cycle
The complete sequence to carry out a sample test and prepare the system for the next test.

Reaction sequence
The part of the sequence when the sample reacts with the CO_2 reagent and the CO_2 gas is transferred to the detector chamber and measured.

Drain sequence
The part of the sequence when the sampling system is drained and flushed with ambient air in preparation for the next sample.

Digital readout
A 3½ digit readout which displays the CO_2 concentration, when DRAIN indicator is illuminated.

POWER pushbutton
Switches the a.c. supply to the 965 on and off.

READY/DRAIN pushbutton
Depressing this pushbutton initiates each analysis cycle (the cycle stops when the reaction sequence is finished to allow the digital readout to be noted). The indicator lights. The pushbutton is then depressed again to initiate the drain sequence.

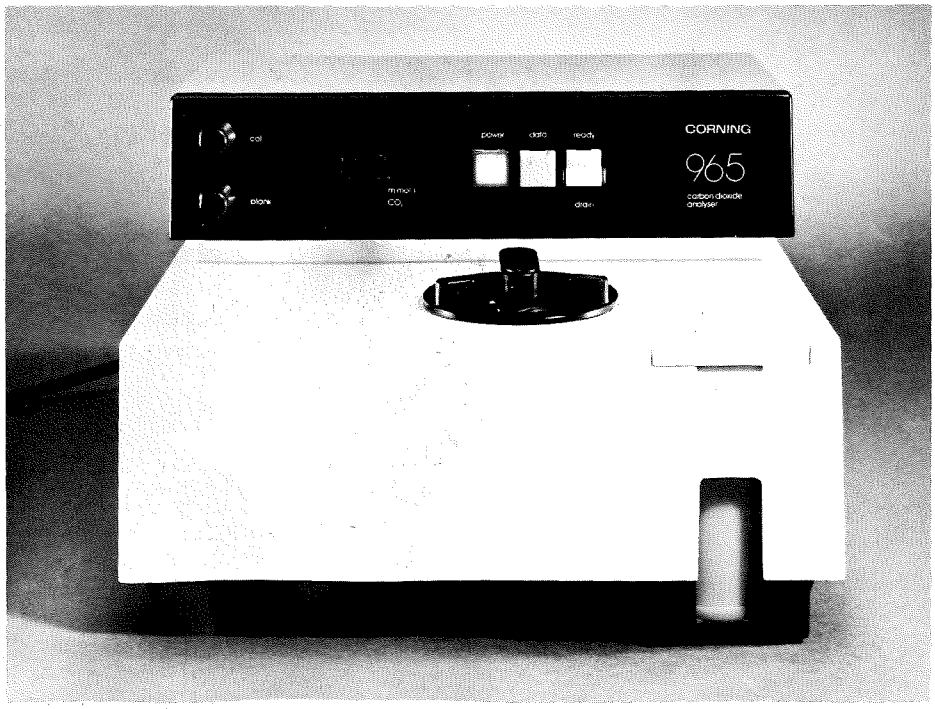

Figure 2.3 Front Panel

BLANK (Zeroing knob)
This control is used to adjust the readout to zero.

CAL (Calibrate knob)
This control is used to set the readout to the precise value of a CO_2 standard (in millimoles per litre) which is present in the detection chamber.

DATA
When the BCD option is fitted this pushbutton, when operated, outputs the digital display reading in BCD format to the rear panel output socket (BCD outlet).

READY indicator
On completion of each analysis cycle, this display will be illuminated to indicate that the instrument is ready for the next sample.

DRAIN indicator
When this display is illuminated, it indicates that the reaction sequence is complete, that the reading can be taken from the digital display and that the chamber must be drained.before inserting another sample.

2.4 Sampling System

Reaction Chamber (Figure 2.4)

The chamber contains a stirrer driven by a belt drive beneath the reaction chamber. The chamber cover is designed to keep the reaction chamber sealed. To inject a sample, the cover must be rotated counter clockwise until the filling hole is aligned over the reaction chamber. Samples should be injected slowly, on to the stirrer paddle.

CO_2 Reagent and Waste Bottle (Figure 2.5)

WARNING CO_2 reagent is corrosive, see Section 4.2, Hazards.

The CO_2 reagent is supplied ready to use in 200 ml bottles. The reagent bottle is placed in the front of the compartment on the right of the sample/reaction chamber.

The waste bottle is placed behind the bottle of reagent.

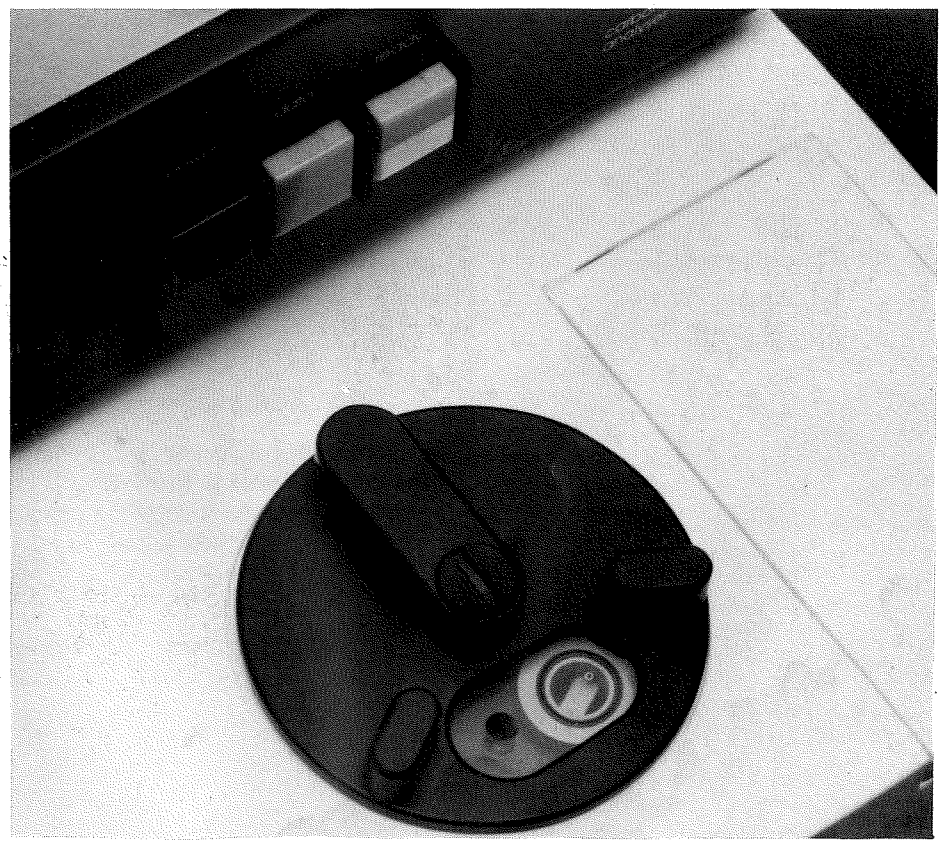

Figure 2.4 Reaction Chamber

Figure 2.5 Reagent and Waste Bottle Compartment

2.5 Rear Panel Electrical Components

Fuseholder
Fuseholder for the fuse that protects the 965.

Fuse ratings:
2 A anti-surge for all instruments.

Optional BCD Outlet Socket
This socket is provided to allow an external interface to be connected to the 965. The output is the display reading in BCD format.

Continuous Drain
A switch that allows the drain pump to be kept running to enable the reaction chamber to be completely drained.

Instrument Zero
Screwdriver adjustable control that provides coarse adjustment of the instrument zero setting, by varying the balance of the bridge detector circuit.

2.6 CO_2 Reagent and Standards

CO_2 Reagent

WARNING The CO_2 reagent is corrosive, see Section 4.2, Hazards.

The CO_2 reagent contains free lactic acid and a blend of reagents to:

a) accelerate the release of carbon dioxide
b) minimise the solubility of carbon dioxide
c) promote draining of the sample from the reaction chamber

The composition per litre is as follows:

Lactic acid	180g
Blend of release accelerators	45g
Blend of drain promoters	55g

The reagent is supplied ready for use. It must be stored at a temperature between 5°C and 35°C and must not be used after the expiration date shown on the bottle.

NOTE A precipitate may form in the reagent during long storage periods or if subjected to freezing temperatures. To dissolve the precipitate see Section 4.1, paragraph 1.

CO_2 Standards

The CO_2 standards (15 mmol/l, 30 mmol/l and 45 mmol/l) are supplied ready for use. These standards should be stored at a temperature between 5°C and 25°C and must not be used after the expiration date shown on the bottle. The standard bottles must be kept capped when not in use.

2.7 Operating Sequence

The following table shows the complete analysis cycle in terms of operator actions, displays illuminated and the processes within the 965.

		Operator Action	*Display*	*Instrument Sequence*
Analysis Cycle / Reaction Sequence	1.	Depress POWER pushbutton	POWER	Power supplied to instrument.
	2.		READY	Instrument ready for the next sample (a small amount of CO_2 reagent is held in the reaction chamber from the previous drain sequence).
	3.	Inject sample	READY	
	4.	Depress READY/ DRAIN pushbutton		
	5.			Stirrer operates to mix the sample with the CO_2 reagent and release any CO_2 present.
	6.			Approximately 0.8 ml CO_2 reagent is pumped into the reaction chamber to transfer CO_2 gas to the detector.
	7.			Stirrer stops. Pause for approx. 5 secs.
	8.		DIGITAL READING DRAIN	
	9.	Note sample reading	DRAIN	Sequence stops until READY/ DRAIN pushbutton is depressed
Drain Sequence	10.	Depress READY/ DRAIN pushbutton	DRAIN	
	11.			Stirrer and drain pump will operate.
	12.		READY	Instrument is ready for the next sample

2.8 Instrument Preparation

1. In the front of the compartment at the side of the sample/reaction chamber are two bottle caps fitted with tubing. Check that one cap is already fitted to the waste bottle, which is located in the rear of the compartment and that the bottle is empty.

WARNING CO_2 reagent is corrosive, see Section 4.2, Hazards.

2. Fit a bottle of CO_2 reagent to the other cap, and place the bottle in the front of the compartment. Ensure that the tube reaches the bottom of the bottle.
3. Check that the tubes to both bottles are not twisted, as this could restrict the flow of the CO_2 reagent.
4. Connect the 965 to the a.c. supply (see Section 2.1).
5. Switch on the instrument by pushing the POWER pushbutton. The green indicator should illuminate. The READY indicator should illuminate. However, if the 965 started operating at some point in the analysis cycle wait until the READY indicator illuminates. If the DRAIN indicator illuminates, depress the READY/DRAIN pushbutton and wait for the READY display to illuminate.
6. Depress the READY/DRAIN pushbutton. When the DRAIN display illuminates depress the READY/DRAIN pushbutton again and wait until the READY display illuminates.
7. Carry out paragraph 6 a total of seven times. This will fill the 965 tubing and pump with CO_2 reagent. During this procedure check that:
   a) The reaction chamber stirrer operates for a period during both the reaction and drain sequences.
   b) The reaction chamber receives CO_2 reagent. The level of the reagent should be visible near the top of the stirrer bar.
   c) The reaction chamber is drained completely during each reaction sequence, apart from a small amount of reagent which is left for the next reaction.
8. It is recommended that the 965 is left on, to overcome the need for a 15 minutes warm up period.

Section 3
Operation

3.1 Calibration

IMPORTANT Always use a pipette which has a pipetting accuracy of ± 1% and a tip design which facilitates injection of samples into the 965.

Care must be taken to ensure as far as possible that *samples are pipetted on to the top of the stirrer.*
See Section 4.1, Paragraph 7.

If the instrument has been switched off *or* has not been used for more than 15 minutes, three conditioning cycles will be required. If the instrument has been used within the preceding 15 minutes only one conditioning cycle will be required.

To ensure optimum results a consistent sampling routine must be adhered to, refer to Section 4.1, Paragraph 10. If the sampling routine is interrupted, it will be necessary to run a single conditioning cycle before continuing with further samples.

1. Check that the waste bottle is not full and that there is sufficient reagent in the CO_2 reagent bottle.
2. Check that the READY indicator is illuminated. If not depress READY/DRAIN pushbutton.
3. Depress READY/DRAIN pushbutton, to initiate a conditioning cycle.
4. When DRAIN indicator comes on, depress READY/DRAIN pushbutton again.
5. When READY indicator is illuminated the detector is conditioned for measurement, providing the 965 has been used within the preceding 15 minutes. If it has not, carry out paragraphs 3, 4 and 5 twice more to condition the detector.
6. Depress READY/DRAIN pushbutton.
7. When DRAIN indicator comes on, adjust BLANK control for a zero display reading (00.0). Repeat blank cycle until a reproducible result within ± 0.5 mmol is obtained.

NOTE If it is not possible to set zero using the BLANK control refer to Section 5.5 and carry out the Instrument Zero Setting procedure.

8. Depress READY/DRAIN pushbutton. While waiting for the READY indicator to illuminate, use a suitable pipette to take up 100µl (or any other selected volume between 50 and 100µl) of 30 mmol/l CO_2 standard.
9. When the READY indicator illuminates, rotate the reaction chamber cover counter clockwise until the filling hole is over the centre of the reaction chamber.
10. Carefully inject the CO_2 standard on to the stirrer in the reaction chamber. Close the reaction chamber by allowing the cover to rotate fully clockwise.

CAUTION Do not hold or rest your hand on the reaction chamber cover, as this could break the seal between the chamber and cover, leading to inaccurate results.

11. Depress the READY/DRAIN pushbutton.
12. When the DRAIN indicator illuminates set CAL control for 30.0 on the display.
13. Carry out a second calibration routine, repeat paragraphs 8 to 12.
14. Repeat paragraphs 4 to 13, until the zero and standard readings are reproducible to within ±0.5 (mmol/litre).

NOTE To improve the accuracy of results for samples whose values are above 40 mmol/l or below 20 mmol/l use the appropriate calibration standard e.g. 45 mmol/l or 15 mmol/l respectively.

Section 3
Operation

3.2 Routine Determinations

After the zero and calibration procedures have been completed, routine determinations can be carried out as follows:

1. With DRAIN indicator illuminated, depress READY/DRAIN push-button.
2. While waiting for the READY indicator to illuminate, take up a sample with the same pipette used to calibrate the 965.
3. When the READY indicator illuminates, rotate the reaction chamber cover, carefully inject the sample on to the stirrer and allow the cover to return to the closed position.
4. Depress the READY/DRAIN pushbutton.
5. When the DRAIN indicator illuminates, record the reading on the digital display.
6. For further samples repeat paragraphs 1 to 5.

NOTE Calibration (Section 3.1) should be checked after approximately ten samples, and also at the end of each batch of samples.

Section 4
Precautions and Hazards

4.1 Operating Precautions

1. When replenishing the CO_2 reagent, check that no precipitate has formed in the solution. Precipitate can be apparent after long periods of storage or if the reagent is exposed to below freezing temperatures at any time. To dissolve the precipitate, the bottle is placed in water at a temperature of approximately 40°C. The bottle is left in the water for at least 20 minutes, being inverted several times to mix the contents. Before using the reagent it must be allowed to stabilize at room temperature.
2. Before starting each series of measurements check to see if the waste bottle requires emptying.
3. The 200 ml reagent bottle is over size for a quantity of 200 ml, enabling the bottle when empty, to be used as a waste bottle. Therefore it can accept all the discarded reagent and samples.
4. Care should be taken in using any automatic pipette when sampling proteinaceous material (Ref.9). Positive displacement pipettes are recommended for serum and plasma samples. Pipettes working on the air displacement principle will dispense a slightly different volume of serum or plasma sample compared to a calibration standard, because of the difference in viscosity. This will result in errors.
   The pipette manufacturer's instructions must be followed carefully.
5. During the first test each day, check that the stirrer is operating for a period during the reaction and drain sequences. If the stirrer does not operate, refer to Section 5.2.
6. As with any quantitive analytical instrument, the care exercised in the calibration procedures will be reflected in the accuracy of the results.
7. When injecting samples (or standards) into the 965, deposit the sample on to the top of the stirrer. The tip of the pipette should be touched on to the surface of the stirrer, thus improving pipetting accuracy. In addition, do not allow sample (or standards) to run on to the reaction chamber cover, which would cause inaccurate readings and contaminate the 'O' ring seal, necessitating removal of the cover for cleaning. Refer to Section 5.2.
8. To inject samples or standards into the 965, use a pipette that has a pipetting accuracy of ±1% and suitable tip design to facilitate injecting samples into the 965.
9. Reproducible results depend upon a gas-tight seal between the reaction chamber and cover. To maintain this seal **do not** hold or rest your hand on the reaction chamber cover. Also ensure that the 'O' ring seal is checked regularly. If liquid is present on the underside of the cover, outside the seal, this indicates a leaking 'O' ring.
10. The detector is conditioned by the preceding DRAIN cycle. For optimum results, ensure that measurement cycles are started within 10 seconds of the READY indicator illuminating.

Section 4
Precautions and Hazards

4.2 Hazards

There are no unusual hazards to the operator when using the 965. However, care should be exercised concerning the following points.

1. All electrical instruments are potentially hazardous. Ensure that the 965 earth (ground) connector is connected to an earth (ground) point. If there is any doubt concerning the effectiveness of the a.c. socket earth (ground), a qualified electrician should be consulted. For routine operation and maintenance it is not necessary to remove the main cover of the instrument. However, should access be required, first ensure that the instrument is disconnected from the a.c. supply.
2. The CO_2 reagent major constituent is lactic acid, which may cause burns on contact with skin or eyes. Standard laboratory reagent handling and spillage techniques should be employed if contamination occurs.
3. All samples should be treated with the caution accorded to those known to contain pathogenic organisms. Similar care should be exercised when handling components which come into contact with the samples. These should only be handled in the presence of a sterilising agent.

Section 5
Maintenance

5.1 General

The 965 has been designed to provide a long troublefree life with the minimum of regular maintenance. Observance of the following preventive maintenance procedures will keep the instrument at optimum performance and accuracy.

5.2 Reaction Chamber

Reproducible performance of the 965 will depend upon the cleanliness of the reaction chamber and effectiveness of the 'O' ring seal between the chamber and the clear plastic cover. To obtain access to the chamber and 'O' ring seal proceed as follows:

1. Rotate the slotted screw in the centre of the cover ¼ turn in either direction. The cover can then be lifted off.
2. Clean the reaction chamber, the cover and around the 'O' ring seal using a lint free absorbent material.
3. Check that the stirrer can rotate freely.
4. Replace the reaction chamber cover and check that the O' ring is sealing around its circumference by observing the contact ring between the 'O' ring and the cover. If there are gaps in the seal remove the cover and adjust the two hexagonal headed brass screws to achieve an even seal. Replace the cover and ensure that the seal is continuous. If necessary the 'O' ring can by lightly greased with silicon grease before replacing the cover.

IMPORTANT The reaction chamber or stirrer must not be oiled or greased. After many months of use it may be necessary to replace the 'O' ring (a replacement 'O' ring and sachet of silicone grease are included in the 965 Accessory Kit). To order additional 'O' rings refer to Section 7.1.

5.3 Fuse Replacement

1. Disconnect the 965 from the a.c. supply.
2. Locate the fuseholder on the rear panel. Release the fuseholder plastic cap by pushing on the cap and then rotating it ¼ turn counter clockwise.
3. Remove the 'blown' fuse and fit a replacement fuse of the same rating in the plastic cap.
4. Replace the plastic cap and secure it by pushing on the cap and rotating ¼ turn clockwise.
5. Reconnect the 965 to the a.c. power power supply.
6. If the fuse 'blows' again, contact your Corning Medical Representative.

5.4 Lamp Replacement

CAUTION Failure to switch off the instrument can result in an internal fuse blowing, necessitating a service call.

1. Press 'power' pushbutton to switch off the instrument and disconnect from the a.c. supply.
2. With the aid of the Lamp Cover Extractor remove the cover with a gentle pulling movement.
3. Faulty lamp is removed by a straight pull and the replacement lamp is pushed into the recess.
4. Refit lamp cover by pushing until the cover locks in position.

Section 5
Maintenance

5.5 Instrument Zero Setting

This procedure will only be required when it is no longer possible to set zero (00.0) using the front panel BLANK control.

1. Turn the BLANK control fully counter-clockwise, until it reaches the stop, then turn five complete turns clockwise.
2. Using a 6 mm flat blade screwdriver turn the rear panel INSTRUMENT ZERO control fully counter-clockwise, until it reaches the stop, then turn five complete turns clockwise.
3. Turn the CAL control fully counter-clockwise, until it reaches the stop.
4. Check that the READY indicator is illuminated. If not depress READY/DRAIN pushbutton.
5. Depress READY/DRAIN pushbutton, to initiate a conditioning cycle.
6. When DRAIN indicator comes on, depress READY/DRAIN pushbutton again.
7. When READY indicator is illuminated the detector is ready for zero setting, providing the instrument has been used within the preceding 15 minutes. If it has not, carry out paragraphs 5, 6 and 7 twice more to condition the detector.
8. Depress READY/DRAIN pushbutton.
9. When the result is displayed, note the reading and press READY/DRAIN pushbutton.
10. If the reading was positive adjust INSTRUMENT ZERO clockwise, if the reading was negative adjust counter-clockwise.
11. Repeat paragraphs 8, 9 and 10 until the readings are reproducible and within the range 01.0 to −01.0.
12. To carry out sample determinations continue with paragraph 6, Section 3.1, Calibration.

Section 6
Troubleshooting

6.1 Troubleshooting

IMPORTANT Before undertaking any troubleshooting procedures, see Section 4.2, Hazards.

The following is a guide to the correct action to be taken if the instrument appears faulty. Symptoms are shown in capital letters, followed by the possible causes in italics, with the appropriate remedy in normal type. For a particular fault the suggested checks should be carried out and if the fault persists, your Corning Medical Representative should be contacted.

1. NO INDICATORS ARE ILLUMINATED

   a) *Instrument not connected to an a.c. power supply or not switched on:*
   Connect to a.c. power supply and switch on.

   b) *Fuse 'blown':*
   Replace fuse (Section 5.3).

2. DIGITAL READOUT VALUES ARE LOW OR NOT REPRODUCIBLE, ZERO SETTING IS MAINTAINED

   a) *Stirrer in the reaction chamber is not operating:*
   Remove the reaction chamber cover and clean the chamber and stirrer (Section 5.2). Possible drive belt failure.

   b) *CO_2 reagent bottle empty:*
   Replace CO_2 reagent bottle and empty waste bottle. Run five analysis cycles to fill the tubing and reagent pump (Section 2.8).

   c) *Reaction chamber 'O' ring seal leaking:*
   Clean and lightly grease the 'O' ring (Section 5.2) or fit a new 'O' ring. Also check cover setting up.

   d) *Insufficient CO_2 reagent injected into the reaction chamber at the end of the reaction sequence to transfer the CO_2 gas to the detector:*
   Check that the level or reagent in the reaction chamber is near the top of the stirrer bar at the end of the reaction sequence.

3. CANNOT ADJUST DIGITAL READOUT TO STANDARD CONCENTRATION VALUE

   Refer 2a, b, c and d.

4. DIGITAL READOUT SHOWS A HIGH NEGATIVE NUMBER OR NEGATIVE OVERRANGE

   (−1 most significant digit, other digits blank.)

   a) *CO_2 reagent transferred to detector chamber:*
   Set CONTINUOUS DRAIN switch, on rear panel, to ON for two minutes. If fault still apparent, contact your Corning Medical and Scientific Representative for assistance. **Do not** attempt to operate the instrument.

5. ZERO CONTROL RANGE INSUFFICIENT TO ADJUST READOUT AT END OF THE REACTION CYCLE

   a) *Detector sample/reference circuits are unbalanced:*
   Set up the Instrument Zero control, refer to Section 5.5.

6. DIGITAL READOUT AT ZERO

   a) *CALIBRATE control adjusted to a low reading:*
   Adjust CALIBRATE control clockwise.

   b) *CO_2 reagent bottle empty.*
   Replace CO_2 reagent bottle and run five analysis cycles to fill the tubing and reagent pump (Section 2.8).

   c) *Reaction chamber cover not pressing on 'O' ring:*
   Engage chamber cover by ¼ turn *after* pressing down.

   d) *Tubing between the reaction chamber and detection chamber blocked:*
   The usual symptom of a blocked tube is the inability to calibrate the instrument i.e. a zero reading.

e) *CO_2 reagent supply system is disconnected or blocked:*
If the CO_2 reagent supply lines to the reaction chamber are blocked or disconnected (chamber does not fill during the reaction sequence) there is the possibility of CO_2 reagent spraying inside the 965. If a blockage or disconnected tube is suspected the instrument must not be operated. The 965 should be disconnected from the a.c. supply and the CO_2 reagent bottle removed. Contact your Corning Medical Representative for assistance.

Section 7
Spares

7.1 Spares

Catalog No.	*Description*	*Qty*
001 56 250F	Pack of 6 x 200 ml bottles of CO_2 reagent	1
478 52 300J	MultiCal™ Ampules containing: 160 mmol Na/l, 80 mmol K/l and 30 mmol CO_2/l, pack of 50 x 2 ml ampules	1 pack
478 52 400N	MultiCal™ Ampules containing: 200 mmol Na/l, 100 mmol K/l and 45 mmol CO_2/l, pack of 50 x 2 ml ampules	1 pack
478 52 500E	MultiCal™ Ampules containing: 80 mmol Na/l, 40 mmol K/l and 45 mmol CO_2/l, pack of 50 x 2 ml ampules	1 pack
478 52 600K	Pipetts, polyethylene, pack of 100	1 pack
478 60 900L	Disposable Ampule Breakers, pack of 1000	1 pack
001 42 580K	Fuse 2A, anti-surge	1
001 42 498X	Connector cable socket 6A	1
001 31 081L	'O' ring (for reaction chamber seal)	1

Appendix A

Specimen Preparation and Storage

Blood Samples

Blood samples may be collected by syringe and transferred to a test tube, which must be filled completely and tightly stoppered. (Ref.5.) (Collection under oil is not recommended as CO_2 will diffuse through it.) Alternatively, the sample may be collected in an evacuated tube which must be filled completely. For analysis of serum, plain collection tubes should be used. For plasma samples Heparin (lithium salt) is the recommended anti-coagulant. Serum or plasma should be separated from the red cells immediately. If the serum or plasma is not analyzed immediately it should be stored in a tightly stoppered, completely filled tube. If the sample cannot be analyzed within one hour, it may be stored at 4 – 6°C for up to 24 hours. Before analyzing a refrigerated sample it must be brought to room temperature and mixed thoroughly.

NOTE Samples from anaesthetised patients should be labelled as such because nitrous oxide can seriously affect results, refer to Appendix D.

Appendix B

Quality Control

Good laboratory practice requires that control samples be analyzed regularly. Assayed serum controls with CO_2 values such as Moni-Trol (TM) and Versatol (TM) normal and abnormal, provide the laboratory with suitable materials having known values. The correlation studies in Appendix C indicate that the 965 values should be comparable with those obtained with the Van Slyke (Ref.4) and Skeggs (Ref.2) methods.

Values obtained should be consistent with the limits established by the user and when deviations occur, corrective action should be taken as described in Section 6, Troubleshooting.

Participation in a group quality control programme provides the laboratory with an additional measure of performance. Remember to notify the programme organisers of the change in methodology.

Appendix C

Performance Characteristics

Precision

Using the 965 'within the day' precision studies were performed on 'normal' 'low' and 'high' pools of sera.

Results:	*Low Pool*	*Normal Pool*	*High Pool*
Number of samples	20	20	20
Sample mean value mmol/l	10.47	22.31	44.64
Standard Deviation of sample	0.29	0.16	0.76
Coefficient of Variation (%)	2.81	0.70	1.71

Accuracy

Thirty seven random samples were analyzed for CO_2 using the 965 and the Auto Analyzer (TM)

The results of the comparisons were analyzed statistically. At the 95% confidence level, there is no significant difference between the averages of both methods.

T -Statistic = 1.695, with d.f. = 36

Sample Size	37
Range of values on the Auto Analyzer (TM) mmol/l	17 to 39
Range of values on the 965 mmol/l	17.9 to 37.4
Mean on the Auto Analyzer (TM) mmol/l	24.1
Mean on the 965 mmol/l	23.8
Bias	−0.3
Standard Deviation Between Methods	±0.99 mmol/l
Paired t-test Significance (at 0.05)	None

Three reference serums which had been analyzed by the Auto-Analyzer (TM) method were analyzed in random sequence for a total of 15 analyses on the 965.

Auto-Analyzer mmol/l	*Corning 965 mmol/l*
10.0 ± 0.5	10.8; 10.6; 10.5; 10.7; 10.5.
24.0 ± 1.0	24.0; 24.3; 24.0; 24.1; 24.2.
45.0 ± 2.0	45.7; 45.6; 45.2; 45.3; 45.7.

Linearity

Linearity of the instrument has been evaluated with aqueous and with serum samples over a range of CO_2 concentrations from 0 to 60 mmol/l. The 965 was found to be linear over this range within ± 1 mmol/l.

Specificity

The instrument measures substances which have all of the following properties:

1. A significant vapour pressure
2. They are not bound by reaction with acid
3. Thermal conductivity different from that of air.

Normally, only CO_2 is present in serum or plasma in sufficient quantities to meet these criteria. Therefore, CO_2 measurements in sera and plasma will be specific to CO_2.

However, some gases e.g. nitrous oxide do interfere with CO_2 measurements, refer to Appendix D.

Appendix C

MEASUREMENT SPECIFICATION

Relative Accuracy
No significant bias (paired 'T' test) against reference method (Van Slyke).

Linearity
Within ± 1 mmol/l over entire (0 to 60) range.
(N.B. Determined by obtaining a mean value for low, high and mid standards on sufficient replicates to eliminate reproducibility factors.)

Reproducibility
When determined by measurement of 10 replicate samples at any level within 0 to 60 range, 2 S.D. will equal ±1 mmol/l.

Detection Limit
Not applicable.

Carryover
Less than 1% of difference between any two consecutive samples within 0 to 60 range.

Stability

(i) Short Term, noise
Not applicable because measurement is made against static gas sample and detector/electronic noise is less than display resolution.

(ii) Drift
- Long Term (multiple samples)
Mean value for repetitive sampling shall not change by more than 1 mmol/l per 10 samples or per 10 minutes whichever is shorter.
- Droop on Single Sample
0.1 mmol/9 sec worst case droop (sample and hold circuitry characteristics).

Response (cycle) time
Overall cycle time will be approximately 36 seconds. This is divided between measure and drain functions as follows:
- sample insertion (start) to steady state reading on display – 30 seconds.
- steady state to 'ready' (i.e. drain cycle) – 6 seconds.

N.B. This is worst case (i.e. longest times) for 50 Hz operation. Cycle times for 60 Hz model will be reduced by 20%.

Sample Requirement

(a) Types of sample – Serum, plasma

(b) Method of presentation – by any suitable commercial pipette similar to Oxford (TM) automatic pipette.

(c) Volume Required – Between 50 and 100µl. (N.B. must be same volume for standards and all samples.)

Reagents
Lactic acid reagent and three standard solutions (i.e. 15, 30 and 45 mmol/l).

Instrument Warm Up Time
24 hour operation recommended. Up to 15 minutes (to attain drift spec. as stated).
NOTE If instrument is left without cycling for longer than 15 minutes, three Blank cycles will be needed to recondition the detector.

Environmental Conditions

(a) Temperature – Operating
10°C to 35°C
Transportation
–40°C to 45°C

(b) Humidity – Operating
85% at 27°C
Transportation
95% at 45°C

Electrical Supply

Voltage – UL/CSA instruments are factory set to 115V, (±10%). Other countries have nominal taps for 100, 115, 200, 220 and 240 Volts (±10%) and are customer adjustable.

Frequency – 50 or 60 Hz
Power – 95 VA (60 Hz)
150 VA (50 Hz)

Other Supplies and Utilities
None

Regulatory Certificates
U.L.
C.S.A.

Appendix D

Expected Values

The values obtained with the 965 correlate with those of the present reference methods (see Appendix C). Therefore the expected values for clinical samples established with the reference methods (Ref.4) should be applicable.

However, it is good laboratory practice that reference values be established by individual laboratories (Ref.8).

Reference Values (Ref.8) (mmol/l CO_2)

	Venous		Arterial	
	Male	*Female*	*Male*	*Female*
Mean	27.4	25.3	25.2	23.1
Range	25–29	23–27	23–27	21–25

Limitations of the Methodology

Interfering substances

Physical
Collection under oil is not recommended unless sample is to be tested immediately, (Ref.5) because CO_2 diffuses.

Intrinsic
As shown in the table, oxygen and nitrogen have very similar conductivity values and both are 70% higher than the value for carbon dioxide. Therefore, small changes in oxygen or nitrogen content do not interfere.

However, the presence of nitrous oxide, which has similar thermal conductivity to carbon dioxide, will cause a positive error, i.e. higher readings. The degree of error will vary depending upon the concentration and the individual patient.

For other species to interfere, they have to satisfy the following requirements.

(a) must be present in a significant concentration and have a significant vapour pressure.

(b) must not be bound by reaction with acid.

(c) must be different thermal conductivity from that of air.

Thermal Conductivity at 0°C ($\times 10^{-6}$ calories/cm^2/sec/°C/cm)	
Oxygen	58.6
Nitrogen	57.4
Nitrous oxide	36.3
Carbon dioxide	34.8

Appendix E

Operating Voltage

The instrument is supplied set to 240V a.c. To change the voltage setting:

1. Remove the reaction chamber cover by pressing down and turning the centre slotted screw a ¼ of a turn in either direction.
2. Remove the six 'Pozidriv' screws from underneath the instrument. (Three on each side).
3. The voltage setting plug is located near the fuse on the rear panel. The voltage setting can be altered by lifting the plug, until it is free to rotate, and replacing the plug so that the required voltage setting is near to the 'V' cut in the side of the mounting plate.

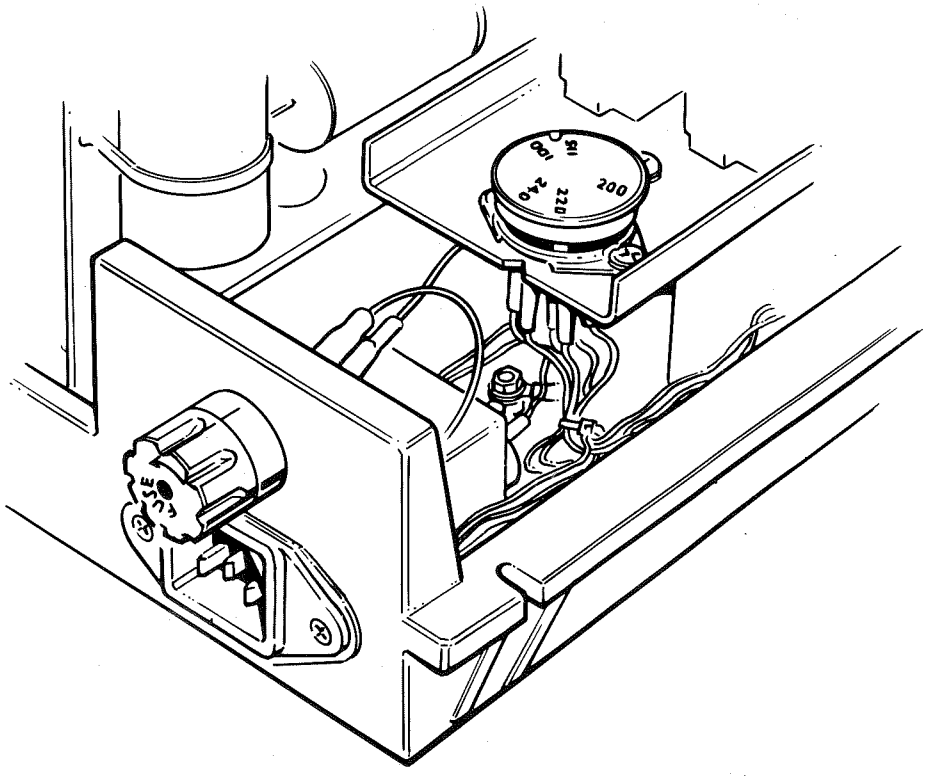

Figure E Voltage Setting Plug

Appendix F

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Appendix G

Draining and packing for shipment

WARNING CO_2 reagent is corrosive, see Section 4.2, Hazards. Before shipping the 965 ensure that the following procedure is carried out to prevent damage to the instrument caused by CO_2 reagent spillage.

1. Remove the bottle of CO_2 reagent from the front of the solutions compartment.
2. Connect the 965 to the a.c. supply.
3. Switch on the instrument by pushing the POWER pushbutton. The white indicator should illuminate. The READY indicator should illuminate. However, if the 965 started operating at some point in the analysis cycle wait until the READY indicator illuminates. If the DRAIN indicator illuminates, depress the READY/DRAIN pushbutton and wait for the READY display to illuminate.
4. Depress the READY/DRAIN pushbutton. When the DRAIN display illuminates depress the READY/DRAIN pushbutton again and wait until the READY display illuminates.
5. Carry out paragraph 4 a total of seven times. This will drain the 965 tubing and pump.
6. Depress the POWER pushbutton to switch off the instrument and disconnect from the a.c. supply.
7. Rotate the slotted screw in the centre of the reaction chamber cover ¼ of a turn in either direction and lift off the cover.
8. Locate the small bore tube, attached to the reaction chamber, that has a Brown marker sleeve.
9. Disconnect this tube from the reaction chamber and tape it to the metalwork alongside.
10. Replace the cover and turn the slotted screw ¼ of a turn to secure it.
11. Remove the waste bottle and empty it. Rinse with deionised water.
12. Pack the 965 in its carton using the original packaging. This will protect it in transit.