Mini GI Gun

DWS

INTERNATIONAL INC.

Mini GI

This new gun is a scaled down model of the well known and appreciated and field proven GI GUN.

The Mini GI is primarily intended to advantageously replace the small Air guns with Wave Shape Kit or Waterguns, normally used for High Resolution / Well Site Surveys.

The good quality of the signal allows the user to design simple and efficient arrays using always the same element, giving to the outgoing signature a high degree of stability.

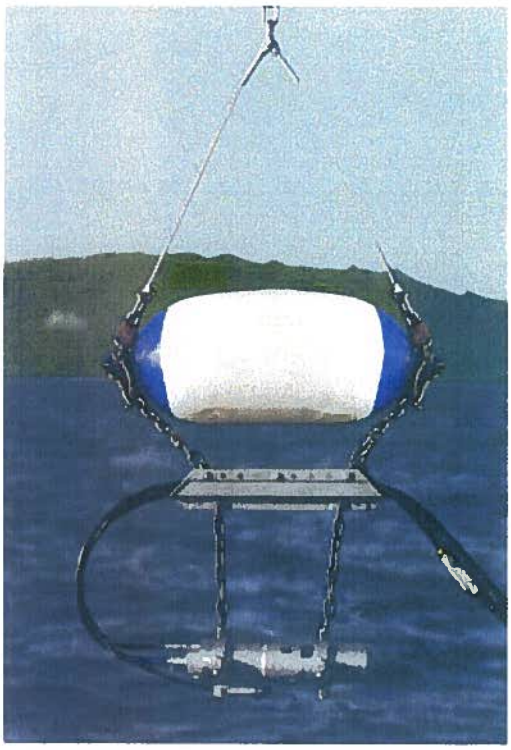
The higher frequency content of the Mini GI spectrum permits a tremendous saving in air consumption when compared to the standard GI GUN.

Indeed, the spectra of the Mini GI 40 (G20 / I20) and the standard GI GUN Hf (G45 / I45) are identical from 200 Hz up, while the air consumption is divided by more than 2.

As for the standard GI GUN, the Mini GI volumes can be easily adjusted by means of inexpensive plastic inserts (see reverse page for the range of volumes).

The standard more of operation is with both Generator and Injector volumes being identical.

However, for special applications where the resolution is the most important factor, then the Mini GI can be used in "True GI Mode" where the Generator is 15 cu.in. and the Injector 30 cu.in. In this case, the P/B ratio jumps up 5 points over the previous mode of operation to reach almost 23 to 1 (DFS 0-256 Hz).



Mini GI Specifications

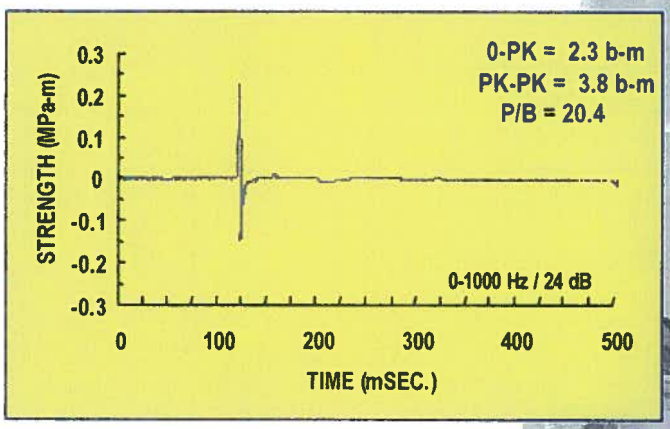
VOLUMES

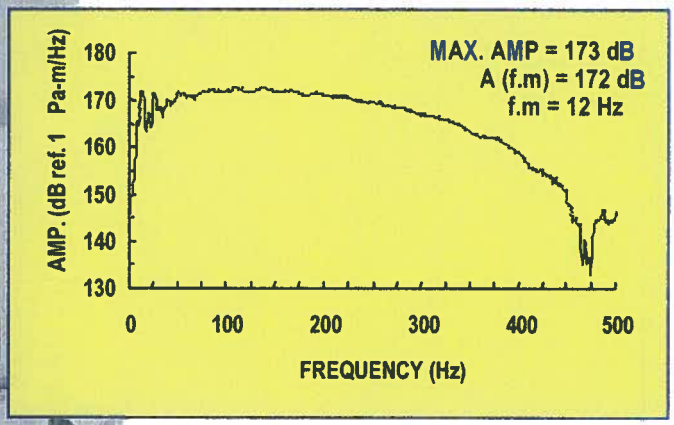
- Generator: from 15 to 30 cu.in.
- Injector: from 15 to 30 cu.in.

PHYSICAL

- Length: 566 mm (22.3")
- Width: 200 mm (7.87")
- Weight: 25 Kg (55 lbs)

RECORDED FAR FIELD SIGNATURE and SPECTRUM





Mini GI (G30 / I30) / 60 cu.in.

Pressure = 2,000 psi

Depth = 1.5 meter

For further information, please contact us at:

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OPERATION AND MAINTENANCE MANUAL

MINI G.I GUN®

COPY

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SAFETY PRECAUTIONS

The following symbols, in this manual, signal potentially dangerous conditions to the operator or equipment. Read this manual carefully. Know when these conditions can exist. Then, take necessary steps to protect personnel as well as equipment.

WARNING This symbol is used to warn of possible serious **personal injury.**

CAUTION This symbol refers to possible **equipment damage.**

TABLE OF CONTENTS

1- INTRODUCTION

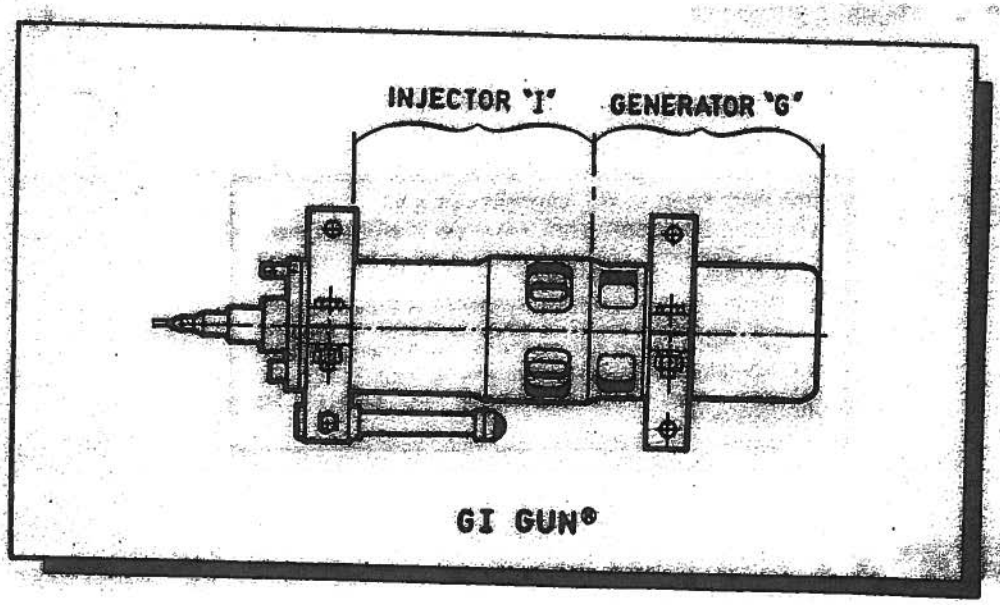
The **GI GUN®** can be defined as
"THE AIR GUN THAT CONTROLS ITS OWN BUBBLE"

It is made of two independent air guns within the same body.

The first air gun or **GENERATOR**, produces the primary pulse, while the second air gun or **INJECTOR**, is used to control the oscillation of the bubble produced by the Generator.

A **gun phone** provides both the **time break** and the shape of the near-field signal for permanent **signature monitoring**. Its location inside the air bubble eliminates crosstalk from other guns.

The volume of both Generator and Injector can be easily changed from 13 in^3 up to 35 in^3, and so can the duration of the injection or its timing.



GI GUN®

This adaptability allows the same mechanism to be used in different ways -or different modes- to achieve different objectives.

- **In the GI Mode** - or "true GI" - the injection is optimally tuned to totally suppress the oscillation of the bubble.

- **In the HARMONIC Mode**, the injection is willingly detuned to reshape and selectively adjust the oscillations of the bubble. For instance a reduced volume of injection can be used to produce a signature having a smooth and reduced oscillation with a greatly improved primary-to-bubble ratio.

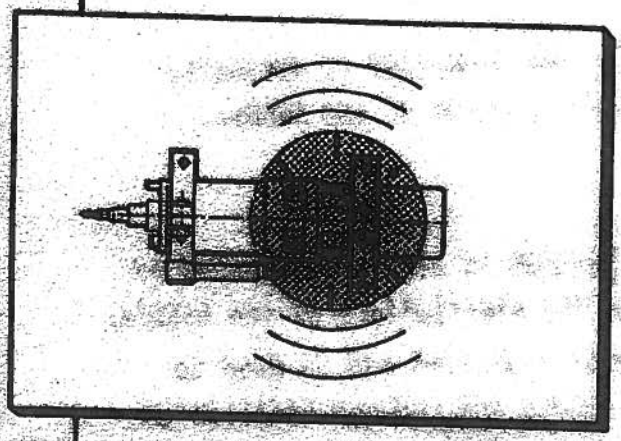
Those reshaped signatures open a wide range of applications, as for instance :

- the design of compact and efficient sub-arrays of 2 or 3 independent guns,
- the use of a single gun for high resolution,

GI Gun has been designed and extensively tested for continuous operation under 3,000 psi air pressure and using this pressure instead of the commonly used 2,000 psi increases the radiated acoustic energy by 50%

G.I GUN®

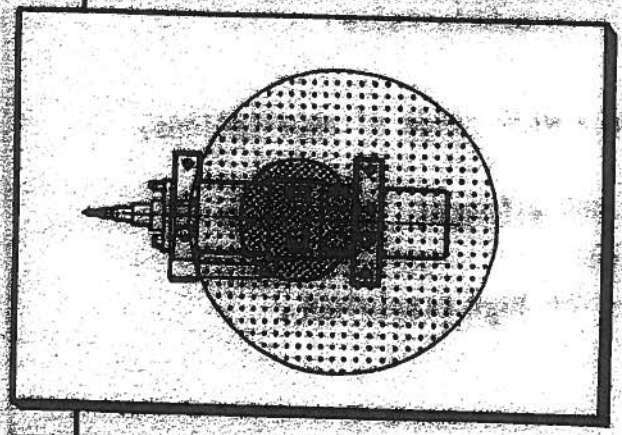
HOW IT WORKS



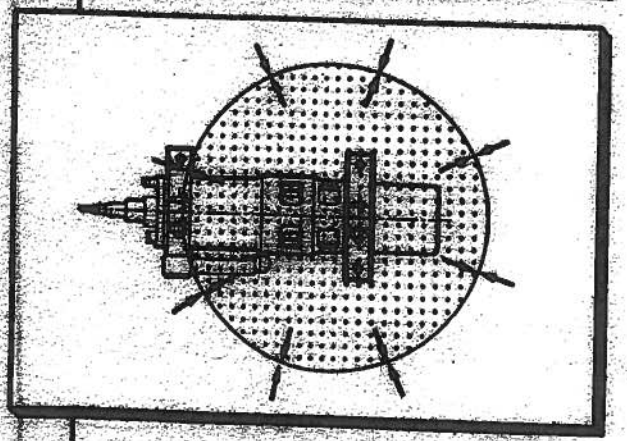
① **GENERATOR "G"** is fired

PULSE IS EMITTED

and the bubble starts to expand...



② When the bubble approaches its maximum size, **INJECTOR "I"** is actuated, injecting air within the bubble.



③ The injected volume of air REDUCES and RESHAPES the bubble oscillation.

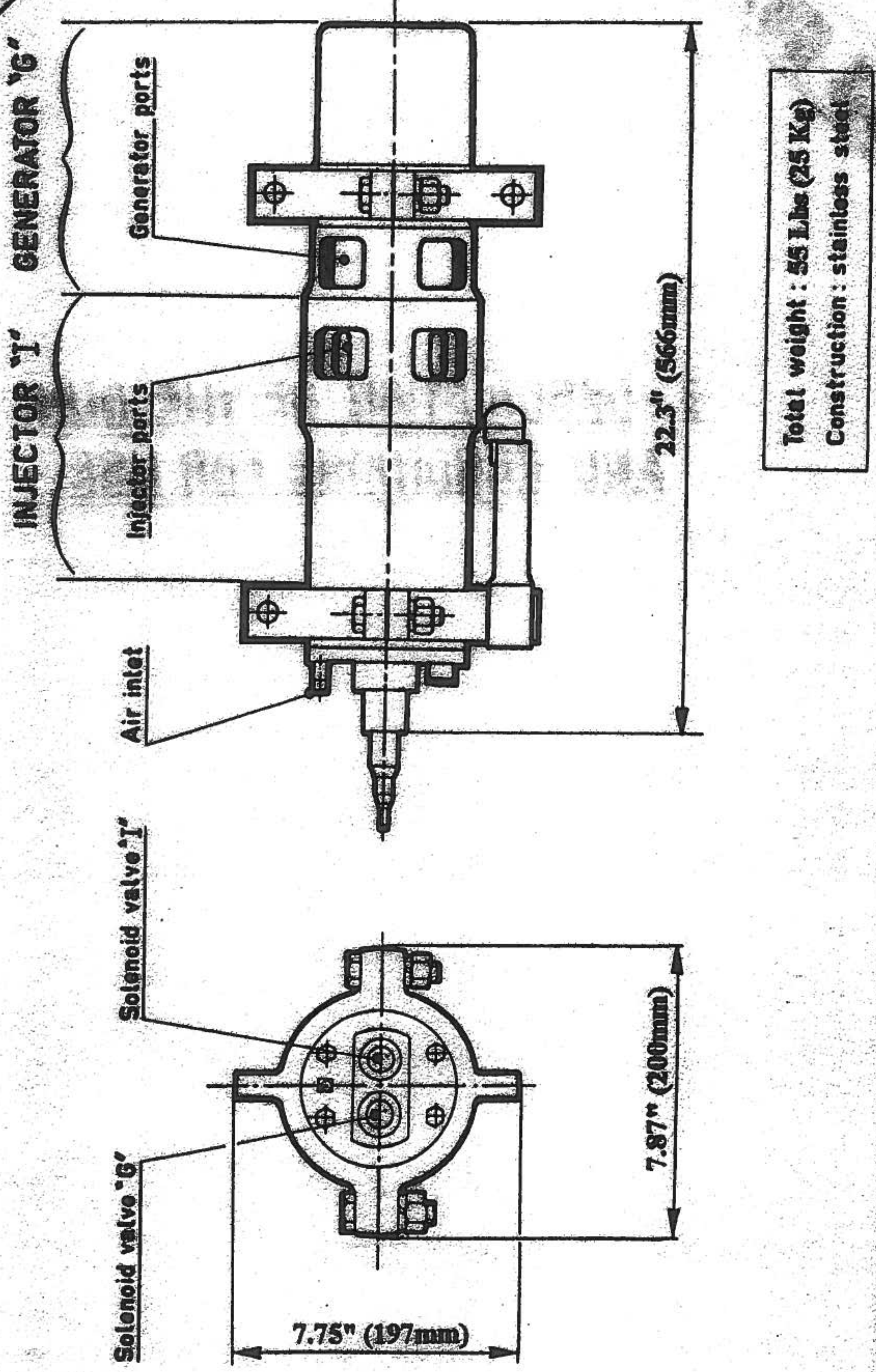
US Patent N°4,735,281 and others pending

For a given volume of Generator, and under given conditions of depth and pressure, there are three parameters which enable the user of GI GUN to model the signal to his will. These parameters are :

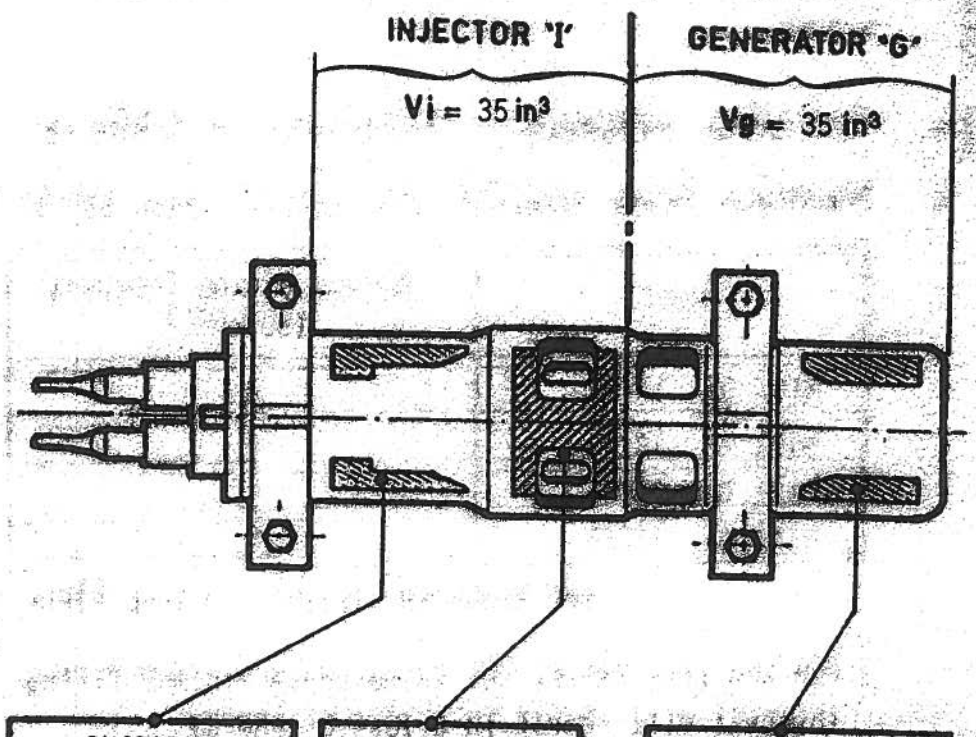
- The volume of air to be injected (adjustable by mean of plastic volume reducers).
- The moment of the injection (commanded from the instrument room).
- The flow (duration) of the injection (adjustable by mean of an inner static sleeve set in front of the exhaust ports).

PERSONAL NOTES

2 - DESCRIPTION OF THE GUN AND CONDITIONS FOR USE


GENERATOR "G"
Generator ports
INJECTOR "I"
Injector ports
Air inlet
22.3" (566mm)
Total weight : 55 Lbs (25 Kg)
Construction : stainless steel
Solenoid valve "I"
Solenoid valve "G"
7.87" (200mm)
7.75" (197mm)

G.I GUN® COMPLETE EQUIPMENT



INJECTOR VOL. REDUCER	INJECTOR DISCHARGE PORTS	GENERATOR VOL. REDUCER
650-513 for 13in³	650-119 : SMALL	650-413 for 13in³
650-524 for 24in³	650-120 : MEDIUM	650-424 for 24in³

On request, all volumes of reducers between 13 and 35 in^3 can be supplied.

Standard delivery

GI GUN is supplied fully equipped* for "HARMONIC MODE 70", that is :

- GENERATOR VOLUME REDUCER : NONE
- INJECTOR VOLUME REDUCER : NONE
- INJECTOR DISCHARGE PORTS : 650-120 "MEDIUM"

* with solenoid valves and TB support.

CONDITIONS FOR USE

WARNING

- **GI GUN** should be fired totally immersed in water.

CAUTION

CAUTION

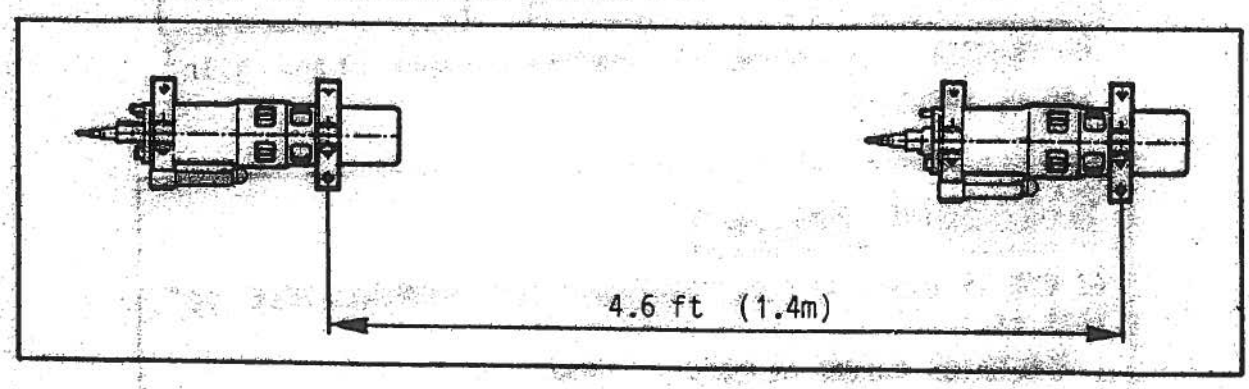
- **Operating pressure** : 1,000 psi to 3,000 psi
- **Minimum firing interval** (For configuration 650 BX 100)

MODE	Minimum Firing Interval (seconds)
MINI GI 13/36	4
MINI GI 13/13	2
MINI GI 24/24	3
MINI GI 35/35	4

(for standard airline 1/4 inch 210ft.)

. Gun can fire faster but to decrease minimum firing interval will result in a loss of energy

- **Non interacting distance:**



- **GI GUN** can be used **horizontal** or **vertical**.
- **Minimum gun depth** : 2ft (0.6m).

3 – REQUIREMENTS

3.1 - AIR

CAUTION The compressed air supplied to the gun must be clean. If the compressor is lubricated with a synthetic oil, an oil coalescing filter must be installed.

3.1.1 - AIR PRESSURE

CAUTION 1000 psi (70 bars) < working pressure < 3000 psi (210 bars)

3.1.2 - AIR REQUIREMENT

Requirement versus firing pressure, volume of the gun and firing interval :

$$SCFM = \frac{2.75 \times P \times V}{1000 \times C}$$

P = Firing pressure (psi)
V = Total volume of the gun (in^3)
C = Firing interval (sec)

or

$$Nm^3/h = \frac{4.14 \times P \times V}{C}$$

P = Firing pressure (bar)
V = Total volume of the gun (liter)
C = Firing interval (sec)

Firing interval versus firing pressure, volume of the gun and compressor delivery.

$$C = \frac{2.75 \times P \times V}{1000 \times F}$$

C = Firing interval (sec)
P = Firing pressure (psi)
V = Total volume of the gun (in^3)
F = Delivery (SCFM)

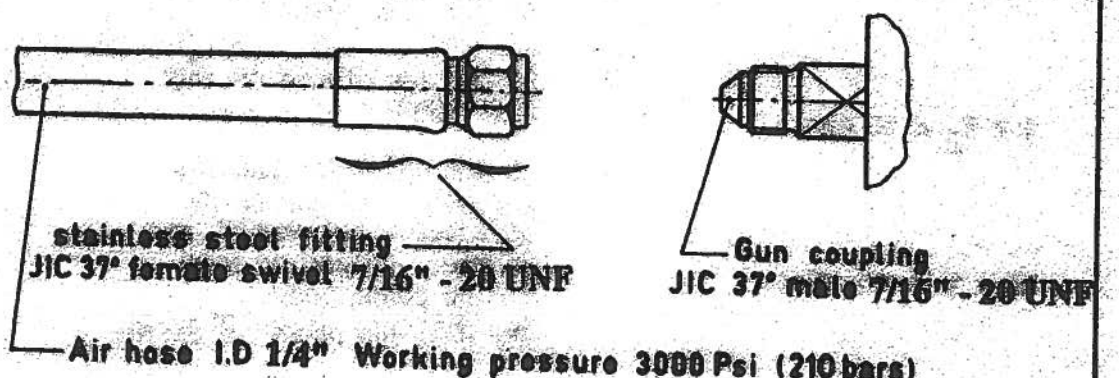
or

$$C = \frac{4.14 \times P \times V}{F}$$

C = Firing interval (Sec)
P = Firing pressure (bar)
V = Total volume of the gun (liter)
F = Delivery (Nm^3/h)

3.1.3. - PNEUMATIC HOSE AND COUPLING

AIR COUPLING

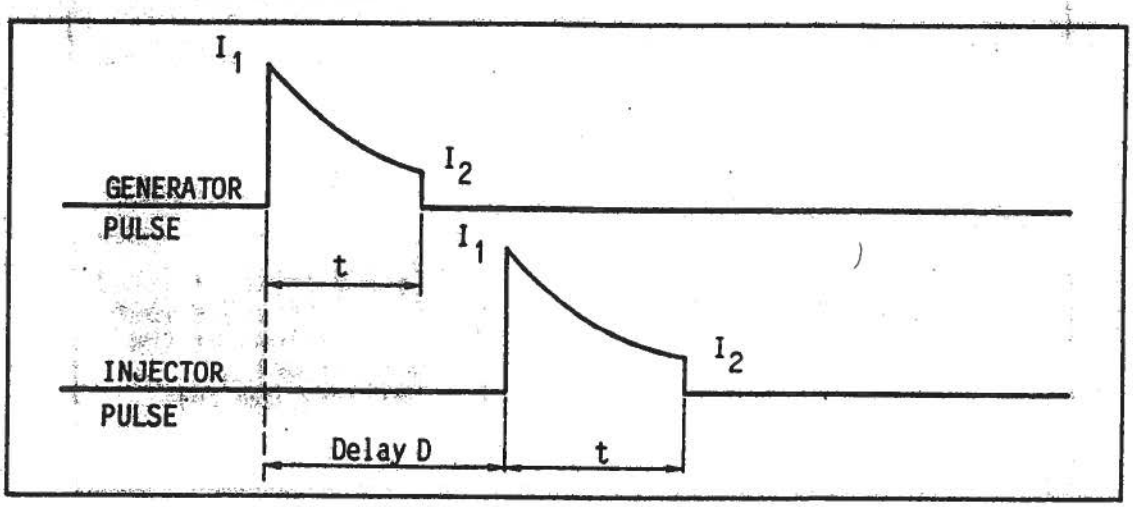


Other fitting, coupling and hose for fast firing rate:

3.2 - ELECTRIC

3.2.1 - PULSES

2 electric pulses are needed to trigger the GI GUN.
One pulse for the Generator and one other pulse (delayed) for the injector.



SPECIFICATIONS

$6 < I_1 < 10$ Amps

$1 < I_2 < 10$ Amps

$30 < t < 100$ mSec.

$$I = \frac{U}{R + 4,3}$$

I Being the current in the line (Amps)

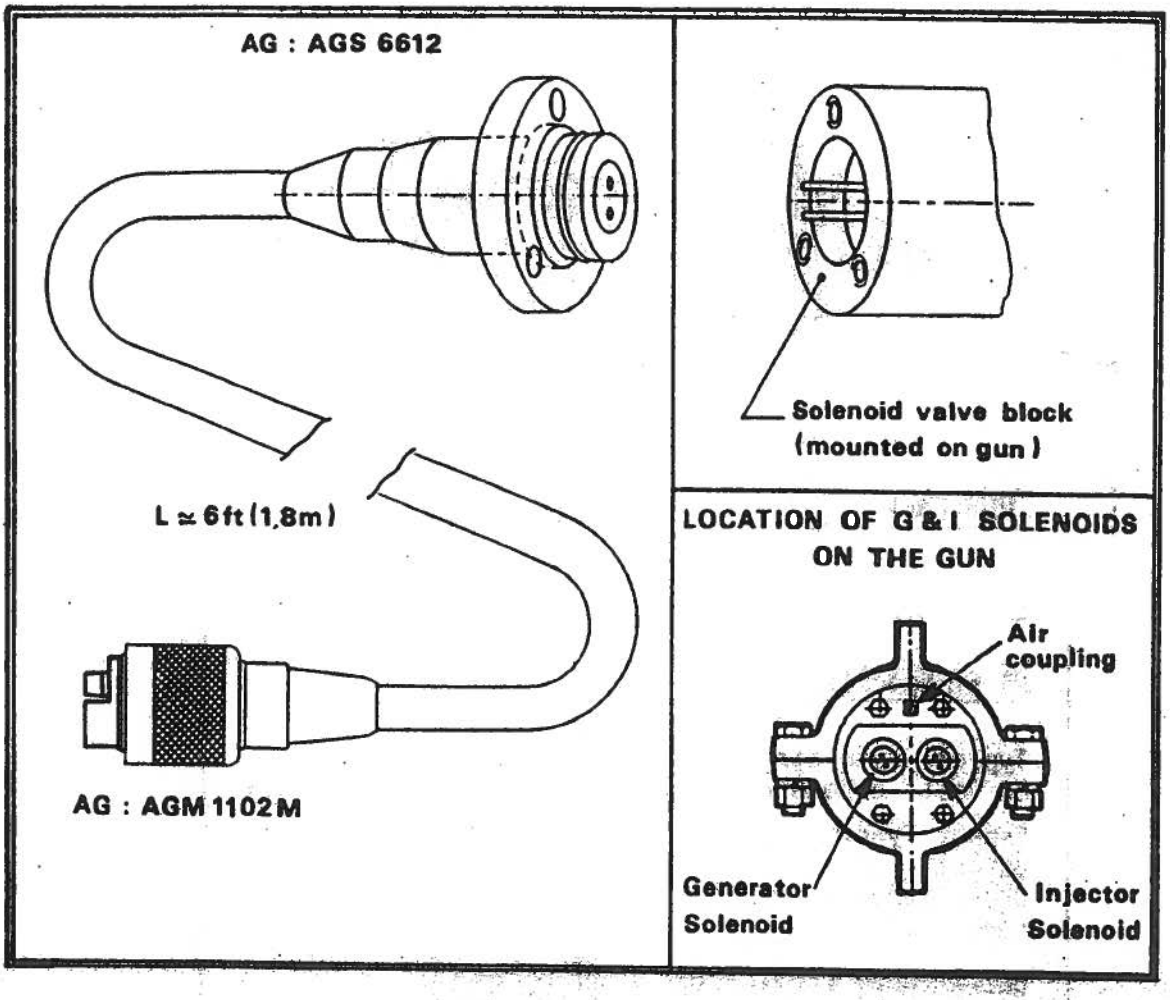
U is the voltage at the head of the line (Volt)

R is the resistance of the line (Ohm)

D is the delay between the 2 pulses. It should be adjustable between 20 and 50 mSec. depending upon firing conditions.
See settings pages 18 to 22

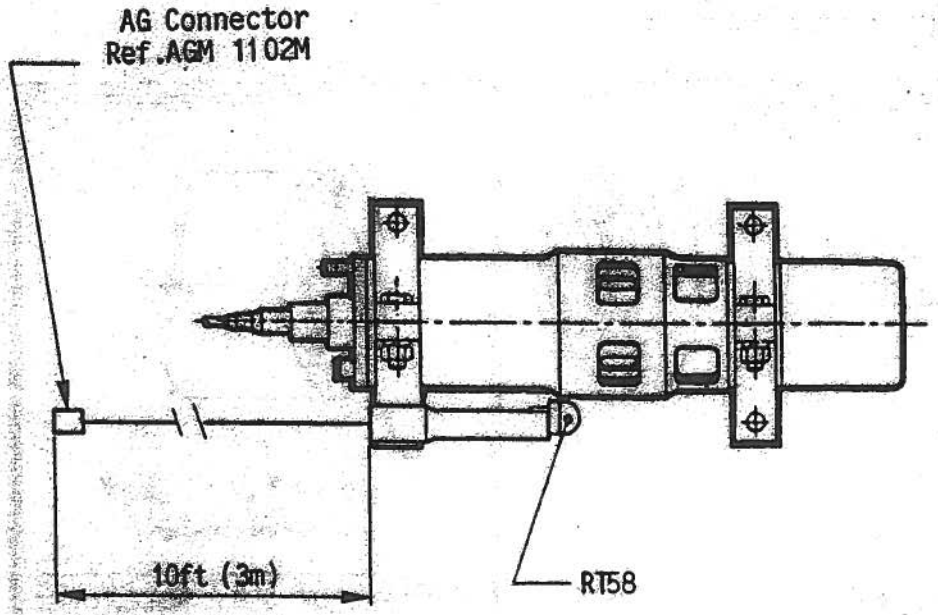
NB : The shorter the risetime of the pulses, the better the repeatability -

3.2.2 - SOLENOID VALVE CONNECTORS



- Coil resistance = 4.3(±10%) ohms
- Coil insulation (under 50 volts) ≥ 100 Kilo ohms

3.2.3. - TIME BREAK DETECTOR



RT 58 Specifications :

Typical open circuit output voltage,
56 volts depending on gun size and firing pressure.

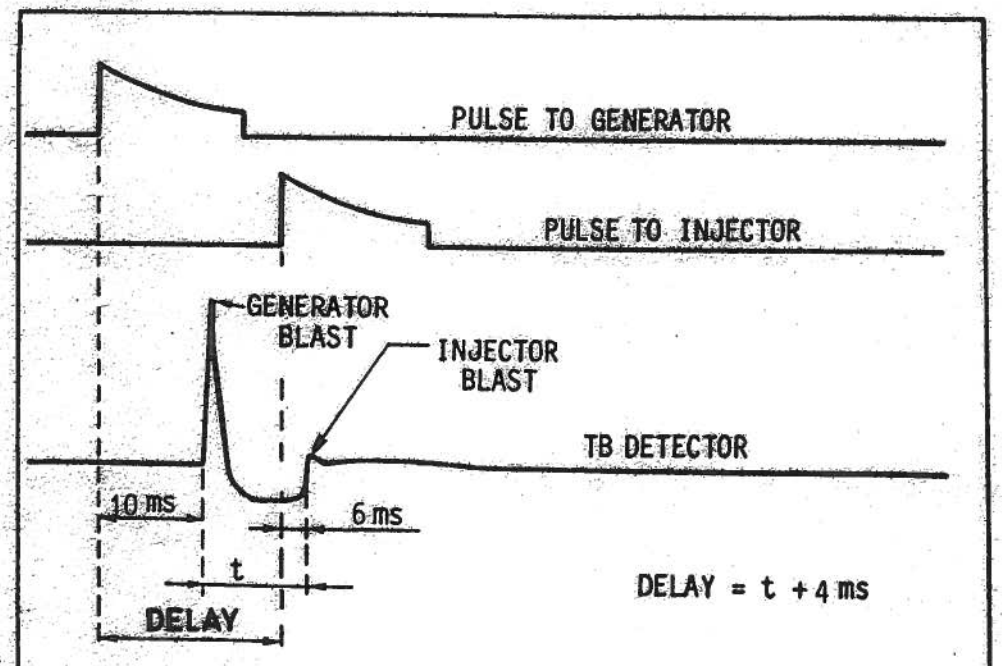
Sensor Type	Piezoelectric
Output	Direct coupled
Capacitance	Approximately 12nFd
sensitivity	Approximately 10 volts per bar, open circuit
Recommended termination	Differential Charge amp, .47nFd capacitance

4-DIFFERENT MODES AND RESPECTIVE SETTINGS

NOTE

Following setting charts constitute a basic indication to help finding the best possible Primary-to-Bubble ratio for each configuration of GI GUN.

For mechanical reasons, timing can slightly differ from one gun to another, and delay could have to be adjusted, in true GI mode, for a few milliseconds, prior to start recording.

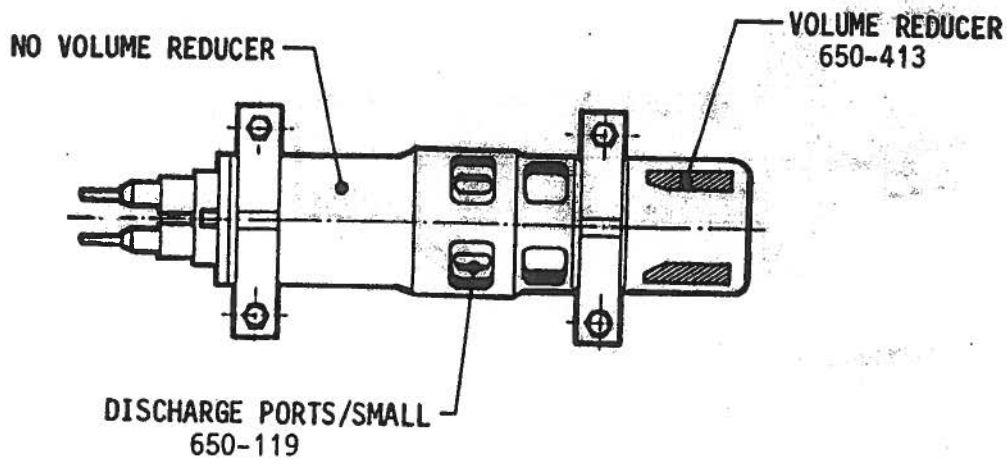


Definition of the **DELAY**

GI GUN®

4.1 – TRUE GI (G = 13 in^3 ; I = 35 in^3 ; small ports)

4.1.1 - CONFIGURATION



4.1.2 - SETTINGS

DELAY SETTING FOR MINI GI GUN
(G13/I35S)

P = 2,000 psi

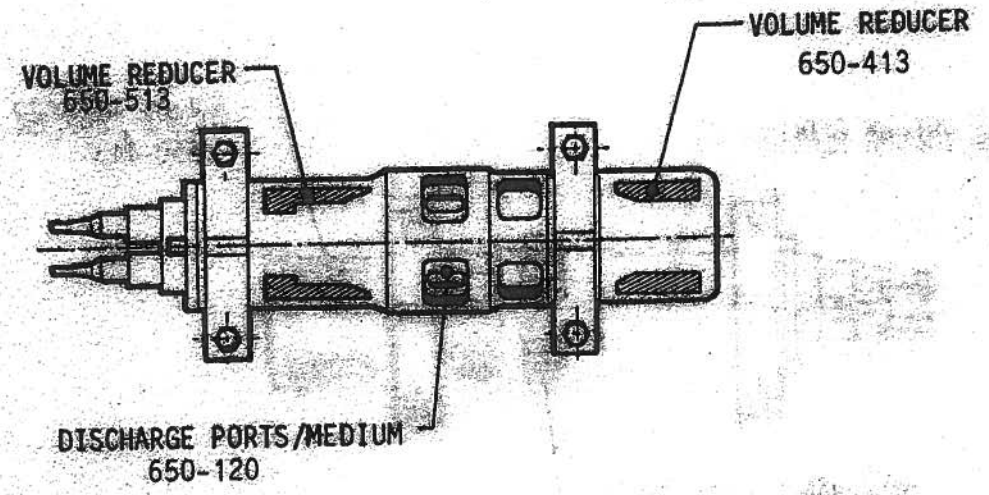
DEPTH (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
DELAY (ms)	28	27	26	25	24	23	23	21	20

P = 3,000 psi

DEPTH (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
DELAY (ms)	32	31	30	29	28	27	26	25	23

4.2- HARMONIC GI (G = 13in^3 ; I = 13in^3 ; medium ports)

4.2.1 - CONFIGURATION



4.2.2 - SETTINGS

DELAY SETTING FOR MINI GI GUN
(G13/I13M)

P = 2,000 psi

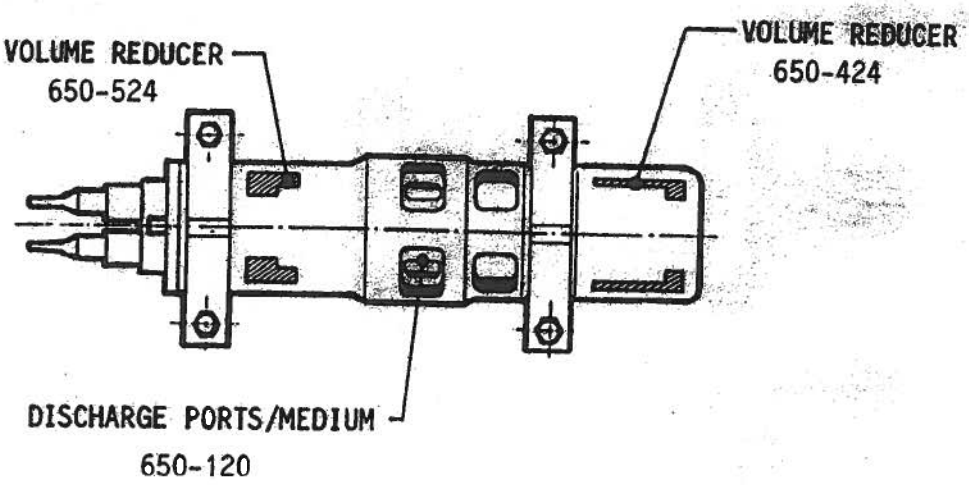
DEPTH (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
DELAY (ms)	29	28	27	26	25	24	24	22	21

P = 3,000 psi

DEPTH (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
DELAY (ms)	33	32	31	30	29	28	27	26	24

4.3- HARMONIC GI (G = 24 in^3 ; I = 24 in^3 ; medium ports)

4.3.1 - CONFIGURATION



4.3.2 - SETTINGS

DELAY SETTING FOR MINI GI GUN
(G24/I24M)

P = 2,000 psi

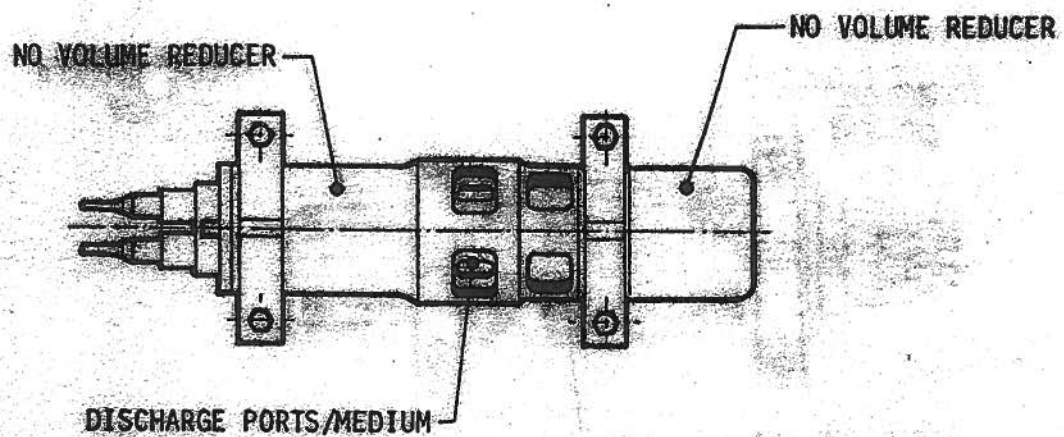
DEPTH (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
DELAY (ms)	35	34	33	32	31	30	29	27	26

P = 3,000 psi

DEPTH (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
DELAY (ms)	40	39	37	36	35	34	33	31	30

4.4 - HARMONIC GI (G = 35in^3 ; I = 35in^3 ; medium ports)

4.4.1 - CONFIGURATION



650-120

4.4.2 - SETTINGS

DELAY SETTING FOR MINI GI GUN (G35/I35M)

P = 2,000 psi

DEPTH (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
DELAY (ms)	40	38	37	36	35	34	33	31	29

P = 3,000 psi

DEPTH (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
DELAY (ms)	46	44	42	41	40	39	37	35	34

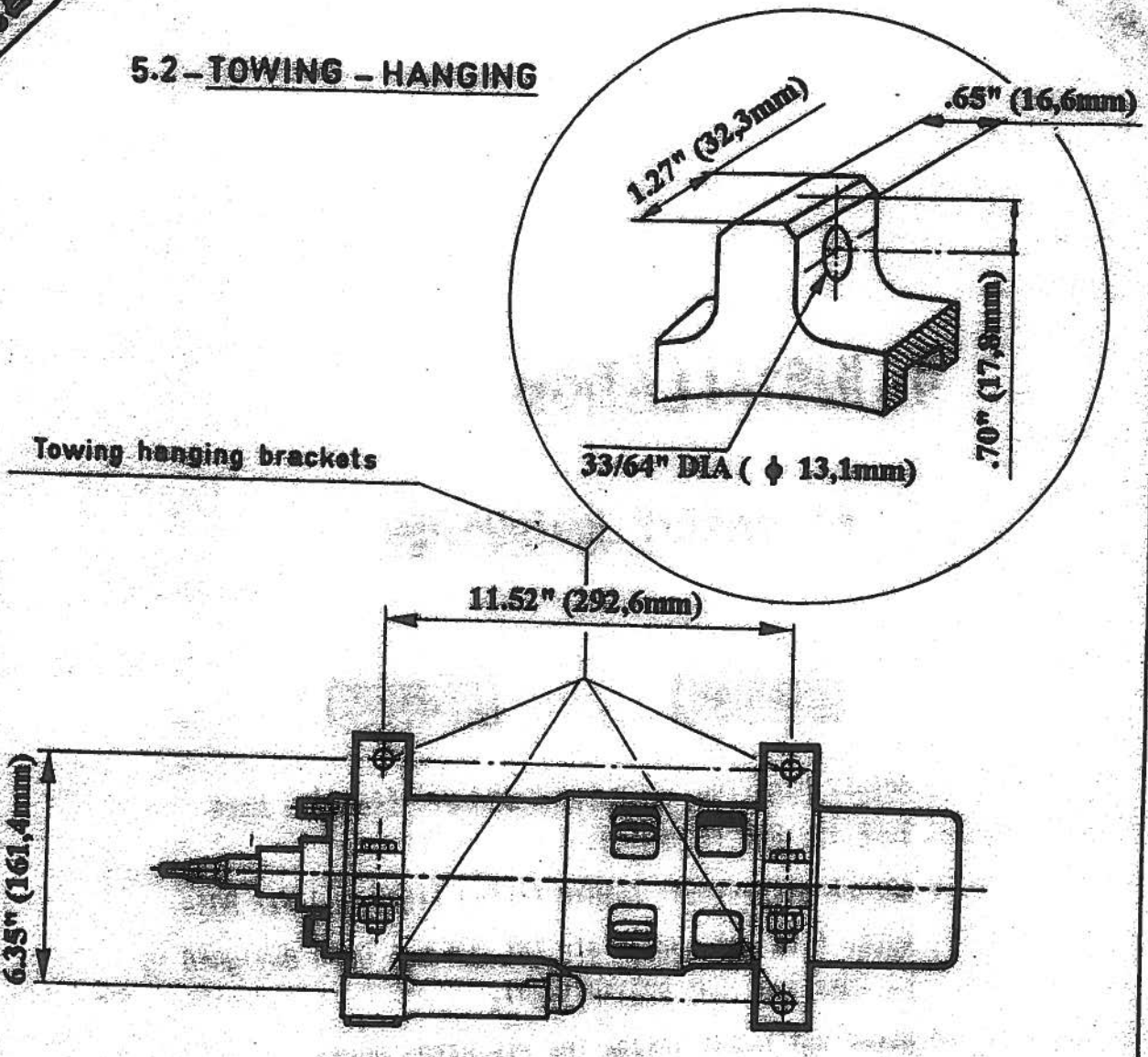
5 - INSTALLATION

5.1 - SAFETY INSTRUCTION

WARNING **CAUTION**

- Before handling, inspection and disassembly, make sure the gun is vented.
- Before disassembly remove firing lines and air hose.
- Never fire the gun in air (GI GUN has been designed to be immersed not pressurized).
- Never put hands inside the discharge ports.

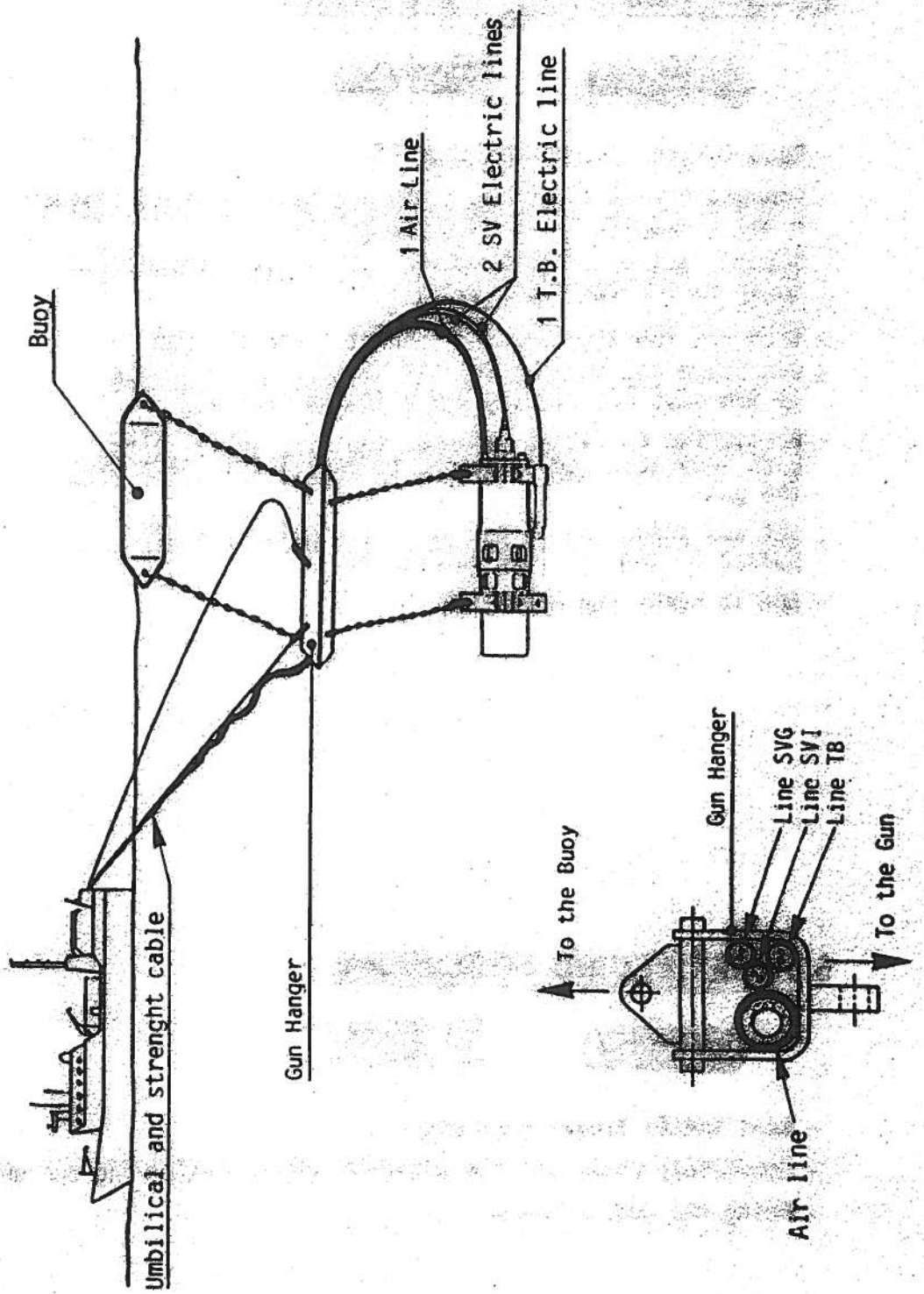
5.2 - TOWING - HANGING



- When gun is towed horizontally, the AIR INLET should be at the top and the lines on the trailing end.

G.I GUN®

5.3- AN EXAMPLE OF TOWING FOR 1 SHALLOW GI GUN



5.4 - OVERBOARDING PROCEDURE

WARNING CAUTION

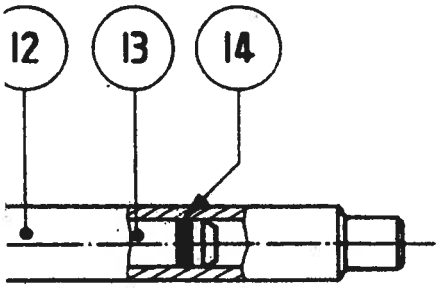
- Read SAFETY instruction page 23
- Connect firing lines (see p.15) and check solenoid valves G and I (should click when energized)
- Connect and check TB DETECTOR (use a water absorption spray to dry the connectors)
- Blow out the air hose and connect it to the gun
- Overboard and immerse the gun without any pressure. GI GUN does not require overboarding pressure
- Pressurize to firing pressure and fire shots, with both Generator and Injector, to expell the water from the gun
- Set and check, on TB detector, the delay between pulses G and I (see chapter 4)
- GUN IS READY FOR OPERATION

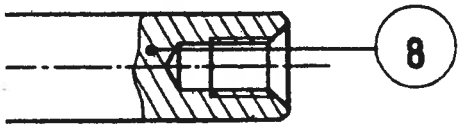
5.5 - RETRIEVING PROCEDURE

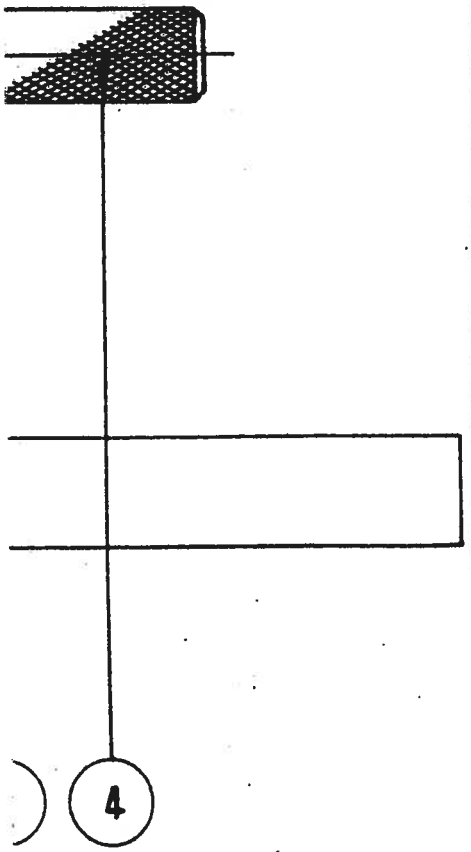
WARNING CAUTION

- Read SAFETY instruction page 23
- Completely bleed off the pressure before retrieving the gun
- Bring the gun on board

UCER HANDLING BAR
plete : (650 XA 2103)







	Drwg location	DESCRIPTION	Part N°	Qty
650 XA 2101	1	SUPPORTING BASE	650 A 2101	1
	2	CENTRAL BRACKET	603 A 2110	1
	3	LATERAL BRACKET	603 A 2109	2
	4	LOCKING SCREW	603 C 2103	2
	5	HEXAGON HEAD SCREW	603 A 315	4
	6	SPRING LOCK WASHER	603 A 317	4
	7	HEXAGON NUT	603 A 316	4
650 XA 2103	8	HANDLE	650 A 2102	2
	9	O' RING GUIDE	603 B 2105	1
	10	DISCHARGE PORTS EXTRACTOR	650 B 2115	1
	11	PUSHER	650 A 2107	1
	12	CYLINDER	650 A 2103	1
	13	SPINDLE	650 A 2104	1
	14	O' RING	650 A 302	1

USE THESE NUMBERS
TO ORDER SPARE PARTS

SEISMIC SYSTEMS INC.
8925 Lipan, Houston, Texas 77063

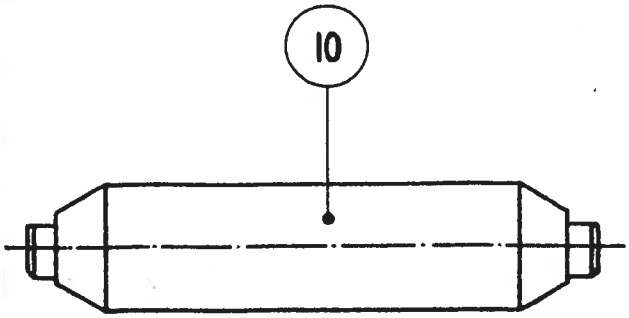
MINI G1

SPECIAL TOOLING

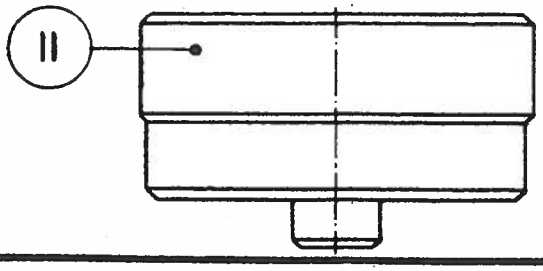
OCT/25/95 By: J.S.

Drawing N°
650AX 2100

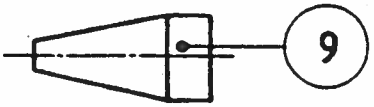
DISCHARGE PORTS EXTRACTOR



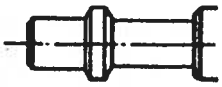
PUSHER



O' RING GUIDE

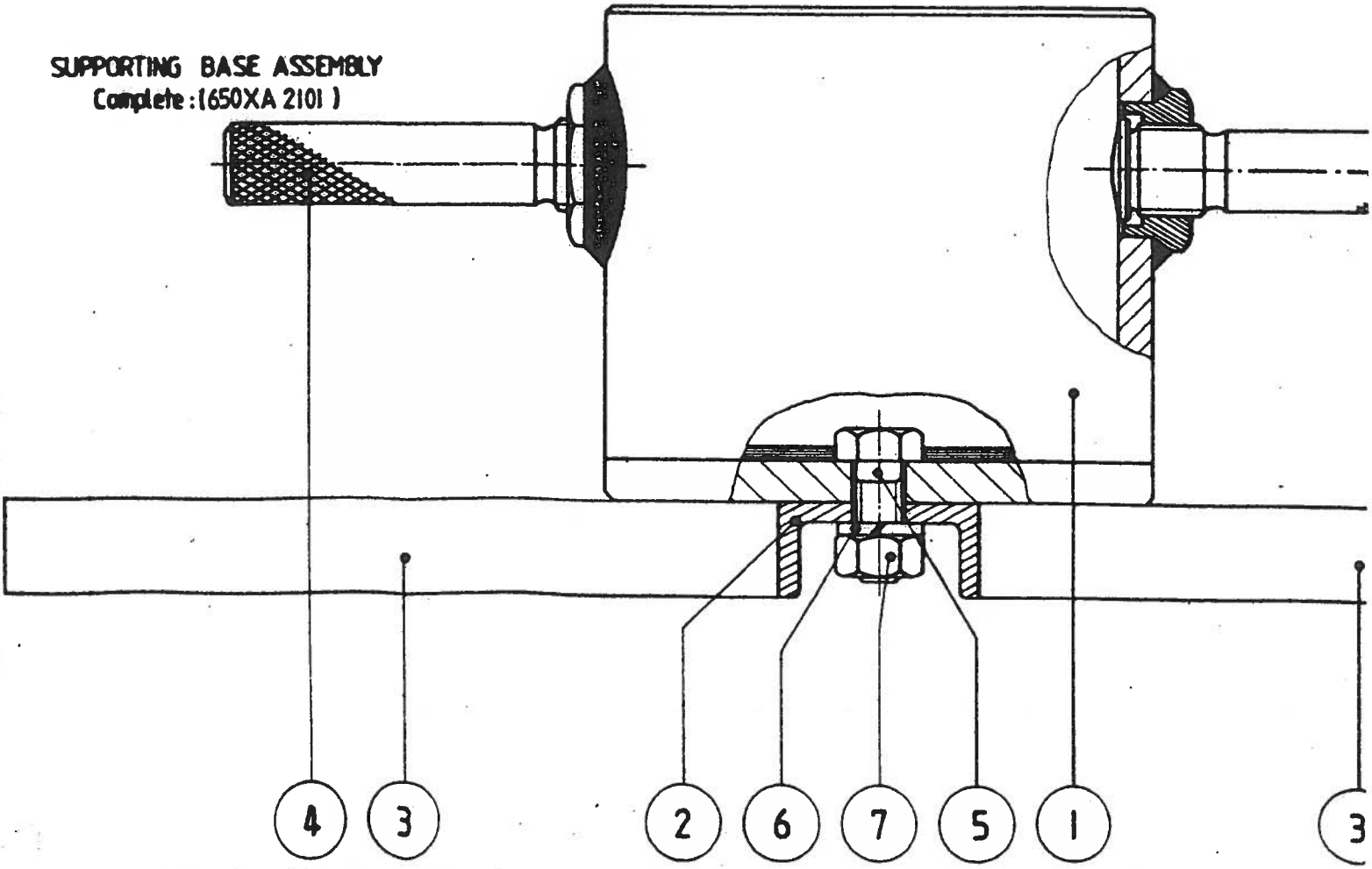


RED
Com



SHUTTLE HANDLE

SUPPORTING BASE ASSEMBLY
Complete : (650XA 2101)



6-MAINTENANCE

PREVENTIVE MAINTENANCE
REDUCES COST OF OPERATION

. To avoid metal/metal bearing, it is important to prevently change shuttle bearings 650-112 and 650-113

CAUTION Minimum thickness acceptable is : .0392 inch (0.995 mm)

The special "NO GO" gauge 650-2301 can be used to check those bearings seated in the shuttle.

. CORROSION

CAUTION After a job at sea, and before a long storage, the gun has to be completely dismantled and cleaned to limit corrosion damages.
For a few hours standby, it is strongly recommended to rinse it copiously with fresh water.

6.1-STANDARD TOOLING

DESCRIPTION	QUANTITY
. 7/8" Flat spanner	1
. 3/4" Flat spanner	1
. 7/16" Flat spanner	1
. 1/2" Long male hexagon socket wrench	1
. 3/16" Long male hexagon socket wrench	1
. Screwdriver (blade .037 x 1/4")	2
. Screwdriver (blade .020 x 1/8")	1
. Rubber hammer	1
. Needle nose pliers	1
. O'ring puller (snap-on 3ASH45 USA)	1

6.2-SPECIAL TOOLING (See page 27)

- GI GUN MAINTENANCE MANUAL

The GI Gun is a very robust tool. Many years of research and development have gone into the design of the gun not only for signal output, but for field reliability. It has been recently brought to our attention that the reliability of the guns is such that they are staying in the water or in service for more than one year before inspection or maintenance. It is pleasing to hear this, but this long mean time before service, has brought up some questions and exposed some potential problems that could occur. This is an attempt to address these situations.

- SERVICING THE GUN

All assembly work should be carried out in a clean, dry environment. Spend some extra time cleaning the work bench and covering it with paper, Clean hands and tools before re-assembling the gun.

Upon disassembly of the gun all seals should be carefully removed and the metal parts washed in fresh water and thoroughly dried. If there has been excessive compressor blow-by or no oil coalescing filter has been used, pre wash the parts in varsol, mineral spirits (paraffin) or a proprietary parts washing solvent and blow dry with shop air. After the parts are completely dry, wipe all of the surfaces paying special attention to the o ring and bearing grooves. Use a lint free shop wiper. This action is to check for burrs or rough spots that may lead to future trouble. If such burrs or rough spots are found, carefully dress down the area with 600 grit crocus cloth or aluminum oxide dressing paper. **DO NOT USE ANY DRESSING PAPER CONTAINING SAND OR FERROUS PARTICLES. DO NOT BUFF THE PARTS WITH A WIRE BRUSH OR USE A FILE.** This will cause rust and pitting because the surface of the part will become imbedded with particles from the cutting medium.

The internal metal parts of the gun have a special anti-friction, corrosion inhibiting coating and care must be exercised to prevent removal of this coating. The coating, which has a very flat finish (in color), will not rub off against the internal bearings and seals but will burnish to a very bright shiny finish and look as if it is worn off, this is normal. If it is necessary to dress down the part minimum material should be removed and the part must be carefully washed to remove the spent cutting medium.

It is permissible to glass bead all metal surfaces to clean, as long as the glass medium is kept no larger than .0083 inch or 212 micron and the air pressure must be maintained lower than 80 psi. The blasting cabinet must be a dedicated unit where only stainless steel or non ferrous metals are blasted.

Use the proper tool for the job. Do not clamp any part of the gun in a vise unless aluminum jaws have been installed. Do not strike any part of the gun with a metal hammer, a plastic "dead blow" hammer is recommended. Never weld or try to re-machine any part of the gun. This is extremely dangerous! If a part is damaged contact Seismic Systems, Inc. or SODERA as the manufacturer and designer of the equipment only these companies have the expertise to do such repairs.

Before re-assembling the gun coat all metal surfaces lightly by hand, with a very thin film of DOW CORNING 111 (ONE ELEVEN) valve lubricant. This serves two purposes. First it is a final check that all parts are burr free and second this lubricating film helps with the installation of the seals and bearings.

Follow the procedure in the assembly portion of the manual carefully observing the correct positions of the internal parts. Because of the long interval between servicing the gun it is possible to forget, and to install the parts out of order. From field experience an improperly assembled gun can be fully functional and repeatable, but will fail in time. This leads to unnecessary expense.

- EXTENDED SERVICE PRECAUTIONS

If after using the GI Gun for a period of time and extended service intervals are the norm, there are a few things that can be done to prevent possible problems.

First, on the GI Gun where the large diameter of the central rod is inserted into the end of the casing, spread a very slight amount of Bostic "Black Moly" never seize into the counter bore or onto the end of the rod. Do not overdo it. A slight amount will prevent any sticking of these two parts when submerged or not disassembled for long periods of time. Do the same on all threaded fasteners to prevent problems.

Secondly, when threading the solenoid base/sub-assembly into the coil housing spread a very light film of the same never seize onto the threads of the sub-assembly. After the assembly has been screwed together hold the coil up to a light and make sure the two parts are completely seated and no light is visible in the crack between them.

Use a spanner of the proper size (do not use pliers or an adjustable spanner) to bring the two parts fully together. Do not over do it. A snug fit is all that is necessary. If the two assemblies are screwed together only hand tight there could be damage to the threads of the sub-assembly or coil housing over a very long time. Thread damage does not mean the parts are ruined only that extra care must be exercised when inserting the solenoid into the sleeve. The threads are only used to hold the two parts together until the assembly is installed in the gun.

- STORAGE

If the gun is left on deck for extended periods of time the minimum service should be a through fresh water flush. When a project or shooting season is over, we strongly recommend complete disassembly of all the guns and solenoid, a through cleaning as detailed above and the parts should be stored in a disassembled state, with no seal on them.

Remember stainless steel is corrosion resistant as compared to carbon steel, it is not corrosion proof, it can corrode or pit if the right conditions exists. Lack of oxygen and the chlorides from sea water are two things that contribute to these conditions.

Because of the longevity of the seals and bearings in the gun it is very tempting to keep the seals in the gun during storage. To save expenses and keep the gun from being damaged it is possible to save the seals and re use them when it is put back into service, but they must be removed from the gun. This can be very tricky logging which seals came from which gun, but it can be done. This practice is only recommended only if spares expenditures must be kept to a bare minimum. The best practice is to always install new seals and bearings when re commissioning the gun. If the seals and bearings are re used after storage do not expect the same service life as obtained from new parts.

When storing the solenoids do not pack the pin connector counter bore or firing line connector with grease. When the gun is re-commissioned it is nearly impossible to remove the all of the grease from either the solenoid or plug and when screwed together the high pressure created will cause damage to the coil housing potting and the solenoid connector. As an alternative use LPS 2 to coat all surfaces to prevent corrosion. This must be washed off upon re-assembly as it forms a waxy film.

Do not spray any petroleum based lubricating solvent into the gun at any time. It is possible for these materials to ignite or "diesel" under high pressure. If extra lubrication is desired pure silicone liquid can be sprayed or injected into the gun without ignition hazard.

In summary the GI Gun will provide the user with years of trouble free service at a very low maintenance cost and very little down time if treated like the precision instrument it is. Because of the long mean time before failure of the gun it is very easy to get into the habit of ignoring the equipment and doing no preventative maintenance. When a problem finally occurs it will be one that could have been easily prevented if proper service schedules and service techniques are performed.

We strongly recommend keeping a daily log of the gun as to performance and maintenance. Over the years this will become an invaluable diagnostic tool.

If specific questions need to be answered or unique problems that occur that have not been addressed here, please contact either Seismic Systems, Inc., U.S.A. or SODERA, France.

PERSONAL NOTES

6.3 - ASSEMBLY

Unfold exploded view page 40

Clean and dry all parts.

CAUTION

Slightly grease o'rings, rings, sliding surfaces with DOW CORNING 111 and threads with a slight amount of Bostic "Black Moly" never seize.

ASSEMBLY is very easy when done in following order (no precise torque needed) :

. PREPARE THE 2 SHUTTLES 5

- Care must be taken not to bend the bearings too much. Make sure they are properly seated in their groove.
- Prepare sealing pack (parts 6, 7, 8, 23) and install it on shuttle.
- Place sliding pack (parts 9, 26, 22).

. PREPARE THE SLEEVE 4

- Install the 2 solenoid valve blocks CX04 33 , the air coupling 15 , the S.V. clamp 16 and screws 31.

. GUN ASSEMBLING

- Put reservoir 3 in the supporting base 2101.
- When needed, install volume reducer 36 in the reservoir.
- Install the stop disk 35.
- Insert one shuttle assembly into the reservoir.
- Insert the central rod 2, with o'ring 25 in the shuttle.
- Install the casing 1 on the reservoir 3. Align slots.
- Clamp casing on the reservoir with half flanges 13 and 14. (Do not forget cotter pins 29).
- Slide discharge port 12 in the casing.
- Slide second o'ring 25 on central rod.
- Insert shuttle 5 into the bore of the sleeve 4 .
- When needed, install volume reducers 34 .
- Insert the sleeve 4 into the casing 1 using handles 2102.
- Clamp casing and sleeve with half flanges 13 and 14.
- Tighten the 4 screws 31.
- Install the 2 jumpers.

CAUTION

- Screw the shipping cap on the air inlet 15 and tape the 8 exhaust ports to protect the gun from foreign matter.

6.4- DISASSEMBLY

WARNING Read SAFETY INSTRUCTION page 23.

Disconnect the 2 jumpers from firing lines.

Disconnect the air line.

Install the gun into the supporting base 2101.

. GUN DISASSEMBLY

- Loosen (but not unscrew) the 4 screws 31.
- Remove upper half flanges 13, 14.
- Separate sleeve assembly from casing (use 2 screwdrivers and then pull it up with handles 2102.

  a) If shuttle comes out with sleeve, insert handle 2102 in holes provided in sealing ring clamp 6 and pull up sleeve assembly.

  b) If shuttle remains inside casing, push it all way down and strike it off.

- Remove lower half flanges 13, 14.
- Remove casing 1 and discharge ports 12 (use tool 2115).
- Pull up shuttle 5 and central rod 2 (tool 2102).
- Separate stop disk 35 from reservoir 3 (screwdrivers).
- If any, extract volume reducer from reservoir (tool 2103).

. SLEEVE STRIP-OUT

- Remove volume reducer 34, if any.
- Unscrew the 4 screws 31 and remove SV clamp 16.
- Remove : 2 solenoid valve blocks 33 (by pulling on jumper) and the air coupling 15 (tool 2102).
- Disconnect jumpers from solenoid blocks

. SHUTTLE STRIP-OUT

- Remove the sliding pack (parts 9, 26, 22).
- Remove sealing pack (parts 6 , 7 , 8 , 23).
- If necessary use tool 2107 to take apart 7 from 6.
- Remove o'rings and bearings (needle nose pliers for the bearings).

7-COLD WEATHER OPERATION

When working under freezing conditions, we strongly advise to inject an antifreeze liquid into the compressed air.

We recommend the compressed air de-icant "NO TOX 2" from "TANNER SYSTEMS".*

The quantity of liquid to be injected depends upon numerous parameters.
Previous operations lead to the average of :

4 in^3/h per 100 SCFM
or 40 cm^3/h per 100 Nm^3/h

EXAMPLE OF PUMP :

SIGMA CHEMICAL INJECTION PUMP 32 CP30

from SIGMA ENTERPRISES INC,
1681 South Broadway
Carrolton TEXAS 75006
(U S A)

Tel. 214 446 8250
Fax. 214 446 8642

---

* TANNER SYSTEMS INC,
1660 East Highway 23
ST CLOUD, MN 56304
(U S A)

Tel. 612 252 6454
Fax. 612 252 3001

8- EXPLODED VIEW and PARTS LIST

ITEM NR.	DESCRIPTION	PART Nr	Qty
1	CASING	650 A 101	1
2	ROD	650 B 102	1
3	RESERVOIR	650 A 103	1
4	SLEEVE	650 A 104	1
5	SHUTTLE	650 B 105	2
6	SEALING RING CLAMP	650 C 106	2
7	SEALING RING	650 A 107	2
8	SEALING RING HOLDER	650 A 114	2
9	BACK UP RING	650 A 108	4
10	SHUTTLE BEARING A	650 A 112	2
11	SHUTTLE BEARING B	650 A 113	2
12	DISCHARGE PORTS	See table 1	1
13	HALF FLANGE	650 A 109	2
14	INDEXED HALF FLANGE	650 A 116	2
15	AIR COUPLING	See table 2	1
16	S.V. CLAMP	650 A 111	1
17	WIPER RING	650 A 308	2
18	O'RING	603 A 301	5
19	O'RING	16 B 146	1
20	O'RING	603 A 302	2
21	O'RING	650 A 303	2
22	O'RING	650 A 312	2
23	O'RING	650 A 307	2
24	O'RING	650 A 305	3
25	O'RING	650 A 306	2
26	CAP RING	650 A 313	2
27	HEXAGON HEAD SCREW	650 A 118	4
28	HEXAGON SLOTTED NUT	650 A 159	4
29	COTTER PIN	226 C 160	4
30	SPRING LOCK WASHER	650 A 304	4
31	SOCKET HEAD CAP SCREW	650 A 314	4
32	SPRING LOCK WASHER	650 A 310	4
33	S.V. CX 04	650 - 400	2
34	VOLUME REDUCER	See table 3	1
35	STOP DISK	650 A 115	1
36	VOLUME REDUCER	See table 4	1

USE THESE NUMBERS
TO ORDER SPARE PARTS

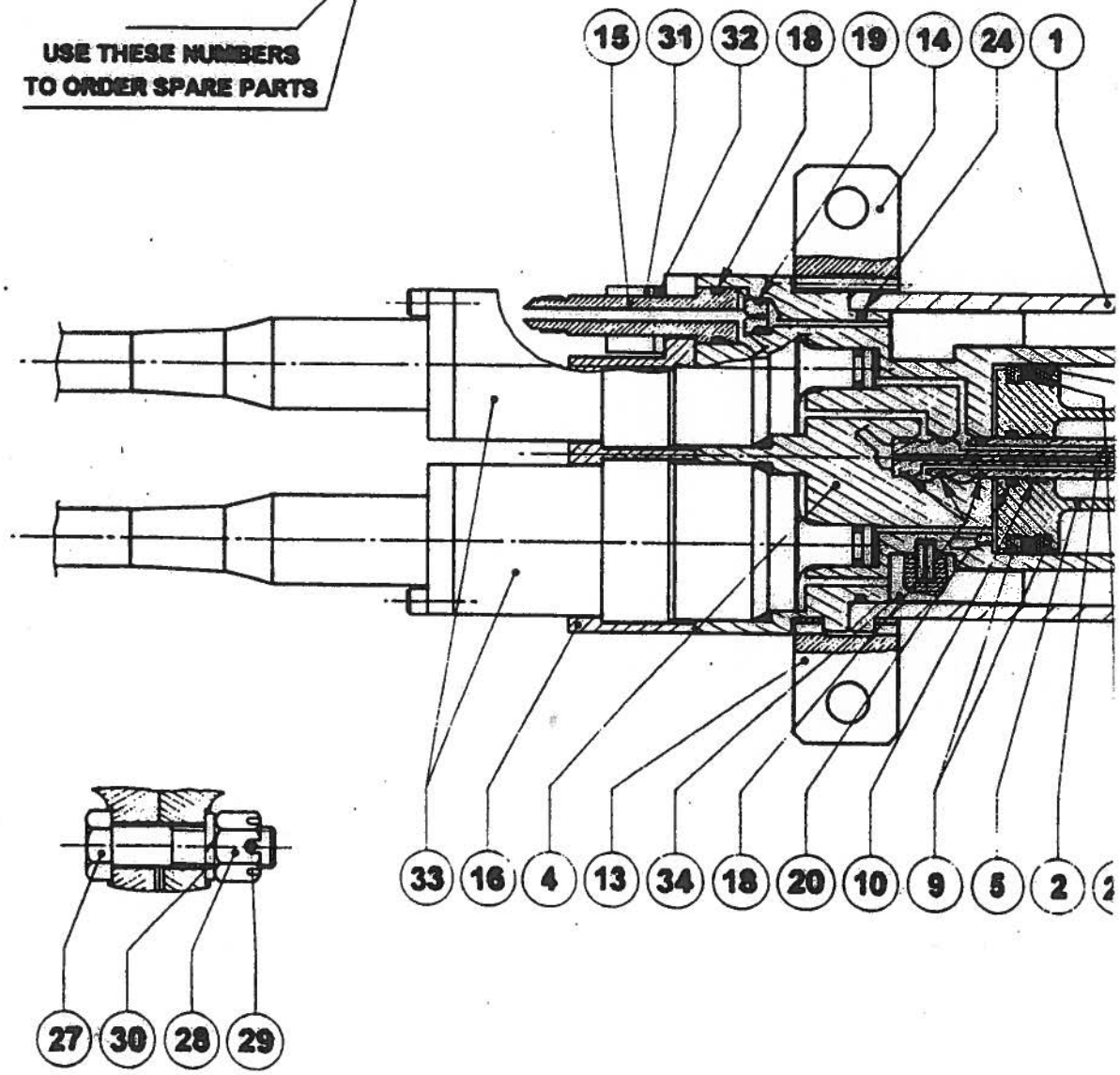
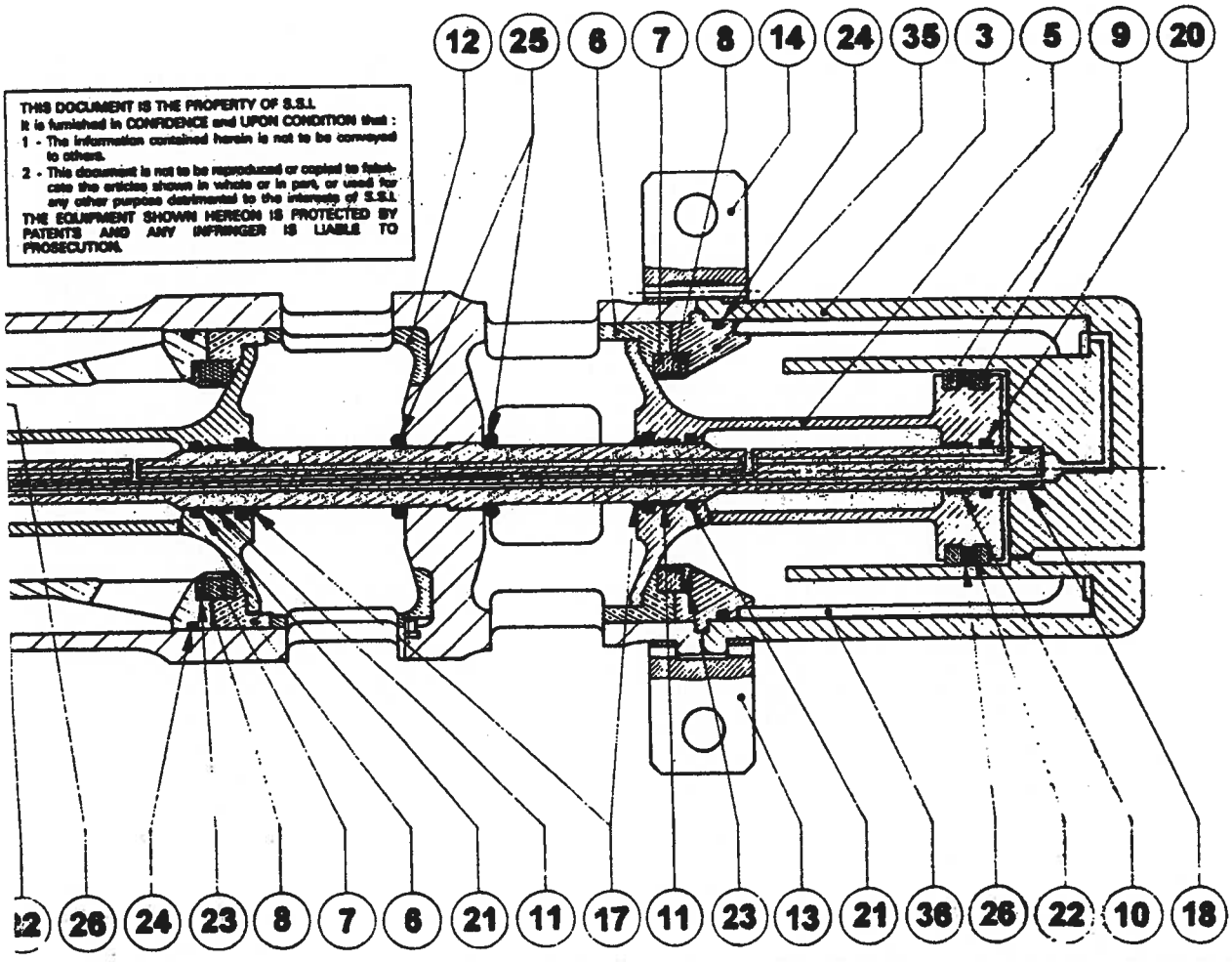


TABLE 1	
DISCHARGE PORTS / SMALL	650 A 119
DISCHARGE PORTS / MEDIUM	650 A 120

TABLE 3	
13 CUIN INJECTOR VOLUME	650 A 513
24 CUIN INJECTOR VOLUME	650 A 524
INJECTOR REDUCERS	

TABLE 2	
AIR COUPLING 7/16	650 B 121
AIR COUPLING 1/2	650 B 117
AIR COUPLING 9/16	650 B 110

TABLE 4	
13 CUIN GENERATOR VOLUME	650 A 413
24 CUIN GENERATOR VOLUME	650 A 424
GENERATOR REDUCERS	



SEISMIC SYSTEMS INC.
8925 Lpan, Houston, Texas 77063

MINI G I

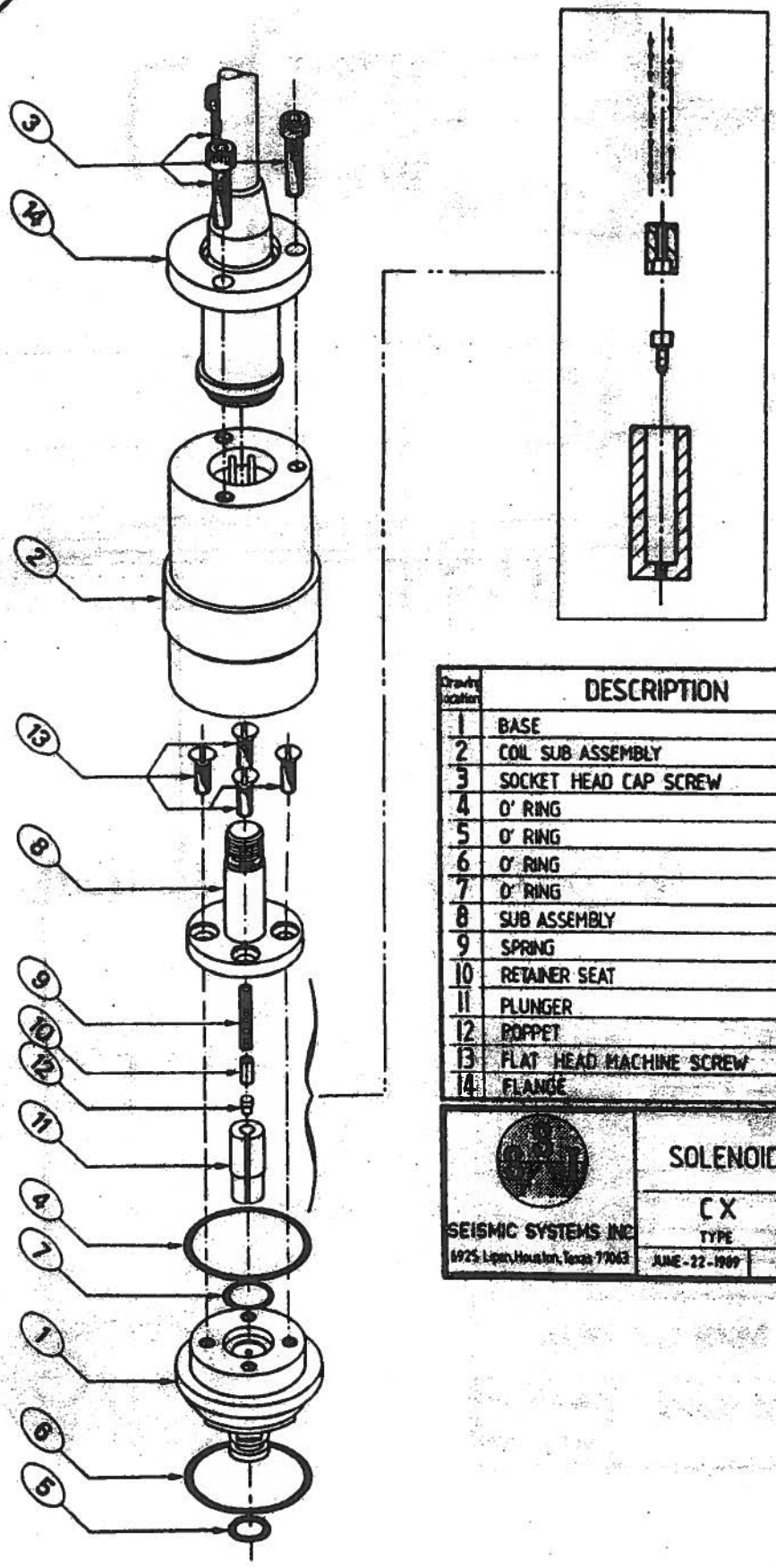
ASSEMBLY

Drawing N°
650 BX 100

12/22/94 | By: J.S.

UPDATED ON OCT/17/96 By : J.S.

G.I GUN®



Drawing location	DESCRIPTION	Part N°	Qty
1	BASE	603 E 401	1
2	COIL SUB ASSEMBLY	16 J 4200	1
3	SOCKET HEAD CAP SCREW	16 B 417	3
4	O' RING	16 A 416	1
5	O' RING	16 B 411	1
6	O' RING	603 A 309	1
7	O' RING	16 A 141	1
8	SUB ASSEMBLY	16 C 3104	1
9	SPRING	16 B 3103	1
10	RETAINER SEAT	16 A 3102	1
11	PLUNGER	16 C 3101	1
12	POPPET	16 B 361	1
13	FLAT HEAD MACHINE SCREW	16 A 414	4
14	FLANGE	603 A 3109	1

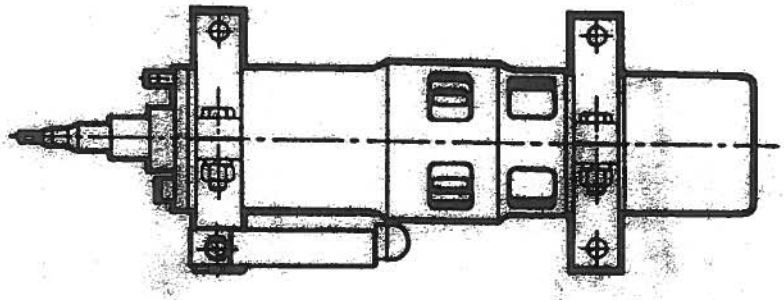
SEISMIC SYSTEMS INC
6925 Lyon, Houston, Texas 77063

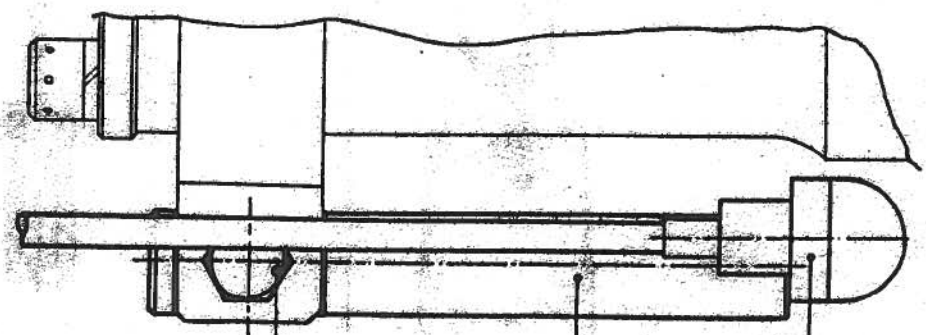
SOLENOID VALVE BLOCK

CX	04	Drawing N°
TYPE	MODEL	603 CX 400
JUNE - 22 - 1989	A. ROBERT	

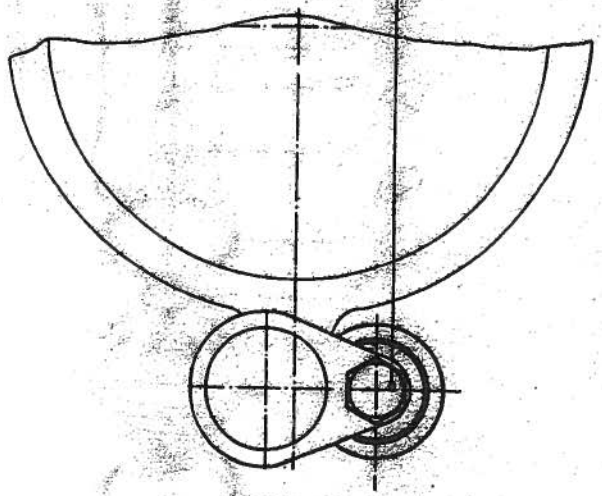
Sodera. France

G.I GUN®





Item	DESCRIPTION	PART Nr	Qty
1	T.B. SUPPORT	650 A 201	1
2	TIME BREAK	R.T.58	1
3	SOCKET HEAD CAP SCREW	650 A 118	1
4	COTTER PIN	226 C 156	1
5	HEXAGON SCREW	297 A 191	1
6	SPRING LOCKWASHER	603 A 317	2
7	HEXAGON SLOTTED NUT	650 A 159	1



SEISMIC SYSTEMS INC.
8925 Dyer, Houston, Texas 77063

MINI G.I. GUN

T.B. SUPPORT

Drawing N°
650 A 200

Sodera . France

9 - TROUBLESHOOTING

9.1 - NO FIRE

POSSIBLE CAUSES	ACTION
Gun and air line full of water (Deployment without pressure)	Send 10 electric pulses to Solenoids G and I in order to expell water
Electric pulse not adapted	See pulse specifications page 14
Bad line(s) or solenoid(s)	Check continuity and insulation (see page 15)
Sticky solenoid valve	Fire the other half gun at maximum pressure
	Clean or change the moving parts of the solenoid
Air circuit plugged	Check air hose
	Check holes inside the central rod and shuttles
Air leakage	Check air hose
	Check the gun
Gun phone, or its line, damaged (the gun fire without feed back)	Change the bad component

9.2 - AUTO FIRE

POSSIBLE CAUSES	ACTION
Bad air tightness	Check on solenoid valves Poppets 12 O'rings 5 Check on gun Sealing ring 7 Cap ring 26 O'rings 18, 20, 22
Unexpected electric pulses	Check firing unit

9.3- BAD REPEATABILITY

POSSIBLE CAUSES	ACTION
Sticky solenoid valve	Clean or change the moving parts of the solenoid.
Bad line(s) or solenoid(s)	Check continuity and insulation (see page 15).
Bad air tightness	See sealing ring 7 and ACTION § 9.2.
Electric pulse not adapted	See pulse spec. page 14
Too short a firing interval	See chart page 10
Air circuit plugged	See ACTION § 9.1
Freezing effect	Use anti freeze recommended page 38
Gun horizontal, air coupling down.	Turn the gun to have air coupling up.

DON'T GET CONFUSED

Keep in mind that what can appear as a bad gun repeatability can well be due either to a poor measurement or to the repeatability of the triggering pulse and threshold of recording system.

9.4 – ANOMALOUS BUBBLE OSCILLATION

POSSIBLE CAUSES	ACTION
Bad timing	Check delay accordingly with chapter 4
Bad firing pressure	Check the pressure and air feeding
Bad gun depth	Check the gun depth
Too short a firing interval	See chart page 10
Air circuit of Generator or injector plugged	See § 9.1
Either Generator or Injector does not fire	See § 9.1
Freezing effect	Use anti freeze recommended page 38
Inversion of G and I firing lines	Reverse firing lines
Confusion on G and/or I volumes	Check G and I volumes (chambers volumes engraved on reducers)

PSI	BAR
100	7
300	21
500	35
700	49
1000	70
1200	84
1500	105
2000	140
2500	175
3000	210

ENGLISH/METRIC CONVERSION CHARTS

FOR APPROXIMATIVE CONVERSION ONLY

MISCELLANEOUS	
1 meter	3.28 ft
1 ft	0.30 m
1 Kilo	2.2 Lbs
1 Lbs	0.45 kg
1 liter/mn	0.26 GPM
1 GPM	3.78 l/mn
1 SCFM	28.35 Nl/mn
1 Nl/mn	0.035 SCFM
1 liter	61 cu.in
1 cu.in	0.016 l

TEMPERATURE
C° = (F°-32) 5/9
35°C = 95°F
30 = 86
25 = 77
20 = 68
15 = 59
10 = 50
5 = 41
0 = 32
-10 = 14
-18 = 0