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MANUAL – PS-1200 Perforation Machine

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Content

- 1. Over-view – attached documents and drawings**
- 2. General technical specifications**
- 3. Introduction of PS-1200 perforation machine**
- 4. Safety instructions**
- 5. Three perforation units**
- 6. Machine rewind and unwind stands**
- 7. Electronic cabinets**
- 8. High-voltage transformer boxes**
- 9. Working principle and installation of electrodes**
- 10. Electrode air cooling and dust exhaust**
- 11. Pneumatic system and functions**
- 12. Adjustment of electrode sets**
- 13. Adjustment of electrode pins**
- 14. Paper web path**
- 15. Operating the machine**
- 16. Perforation control – machine control panel**
- 17. Porosity control – machine control panel**
- 18. Production**
- 19. Quality control and criterium**
- 20. Clean-up and maintenance**
- 21. Additional information**
- 22. General specification - perforation system PS-1200**
- 23. Electrical specification – perforation system PS-1200**
- 24. Mechanical specification – PS-1200**

1. Over-view – attached documents and drawings

Following drawings and documents are added to this Manual :

- **DGW - 1 up to DWG – 26**
- **high-voltage transformer pictures**
- **perforation hole pictures**
- **General specification - perforation system PS-1200**
- **Electrical specification – perforation system PS-1200**
- **Mechanical specification – PS-1200**

2. General Specification - Perforation System PS-1200

electrostatic surface-all-over and certain area perforation

- Plug-Wrap-Paper weight : 20 - 40 g/m²
- porosity range : from 500 - 2000 C.U.
- number of single bobbins and perforation channels : 40
- min. Plug-wrap single bobbin web width : 27 mm +/- 0.3 mm
- max. Plug-wrap single bobbin web width : 28 mm +/- 0.3 mm
- max. web width : 40 * 28 mm (+ 10 mm) = 1130 mm
- surface-all-over perforation : 40 * 12 = 480 single perforation lines across the web
- certain area perforation : 5.0 - 24.0 mm +/- 0.3 mm, symmetrically on each bobbin width
- porosity variation <= 500 C.U. ----- +/- 40 C.U.
501 - 1000 C.U. ----- +/- 80 C.U.
1001 - 2000 C.U. ----- +/- 120 C.U.
depends on paper quality and without optical online porosity scanning system OPSS
- perforation power with three times double web path and a perforation width of 24 mm on each bobbin >=120.000 C.U.*m/min; 500 C.U. = 240 m/min, 2000 C.U. = 60 m/min
- roll web width : 1200 mm
- maximal web speed : 250 m/min
- electrode gap : 1.5 - 1.6 mm max.
- three perforation units cascaded in web direction, each with double web path
- each perforation unit in order of pos. 6; equipped with light running rollers, double web path, three doors, two top 100 mm diameter dust exhaust connector, noise reduced material, leading bars for electrodes, front moveable electrode device for easy web in-let, pin setting device, safety switches, high-voltage connection board, terminal box etc.
- two side-channel-compressors for the electrode air cooling; installed and on the top of the perforation base frame
- rear side positioned high-voltage transformer boxes
- 19“-electronic cabinet; positioned next to each perforation units
- 40 pairs of 12 pin electrodes in each perforation unit
- manual pulse-width control 8 - 12 μs for each perforation electrodes with 40 channels
- manual common frequency control from 1000 - 6000 Hz for all 40 perforation channels
- **option** : automatic porosity scanning and controlling with the OPSS-1 system
- hole-size diameters of all operating electrodes can be influenced by variation of pulse-length duration in ranges from 60 - 120 μm
- hole densities and distances down web can be influenced by variation of spark-repeat frequency, adjustable and synchronised with the web speed or manual between 500 - 6000 Hz to obtain certain hole densities and distances in the web direction and across the web
- machine operation can be carried out with internally fixed spark frequencies or synchronised with the web speed
- perforation control for all electronics and perforation units from the machine control panel

- intervals for electrode pin adjustment : min. after 10 - 12 production hours
- life time of 1.0*80 mm Tungfram ridge free electrode pins : approx. 2.500 operating hours
- electrode air cooling with two side-channel-compressors for each perforation unit : approx. 2 * 200 m³/h by min. of 75 mbar
- one side-channel-compressor for the air-bolster of double web path : air amount approx. 80 m³/h by 50 - 80 mbar
- main power consumption of each perforating unit : approx. 22 KVA
- mains : 3*400V/PE/50 Hz/10mm²-PE
- intercircle voltage : 300V/DC/35A max.
- temperature range : 5 – 35 Grad/C
- dust exhaust amount : min. 3 * 1.800 m³/h by min 200 mmWG -- supplied by the customer

Note : The specifications are indicative and IPM reserves the right to alter or modify such specification if in their opinion and for reasons of technical progress such changes will produce a better piece of equipment.

3. Introduction of PS-1200 perforation machine

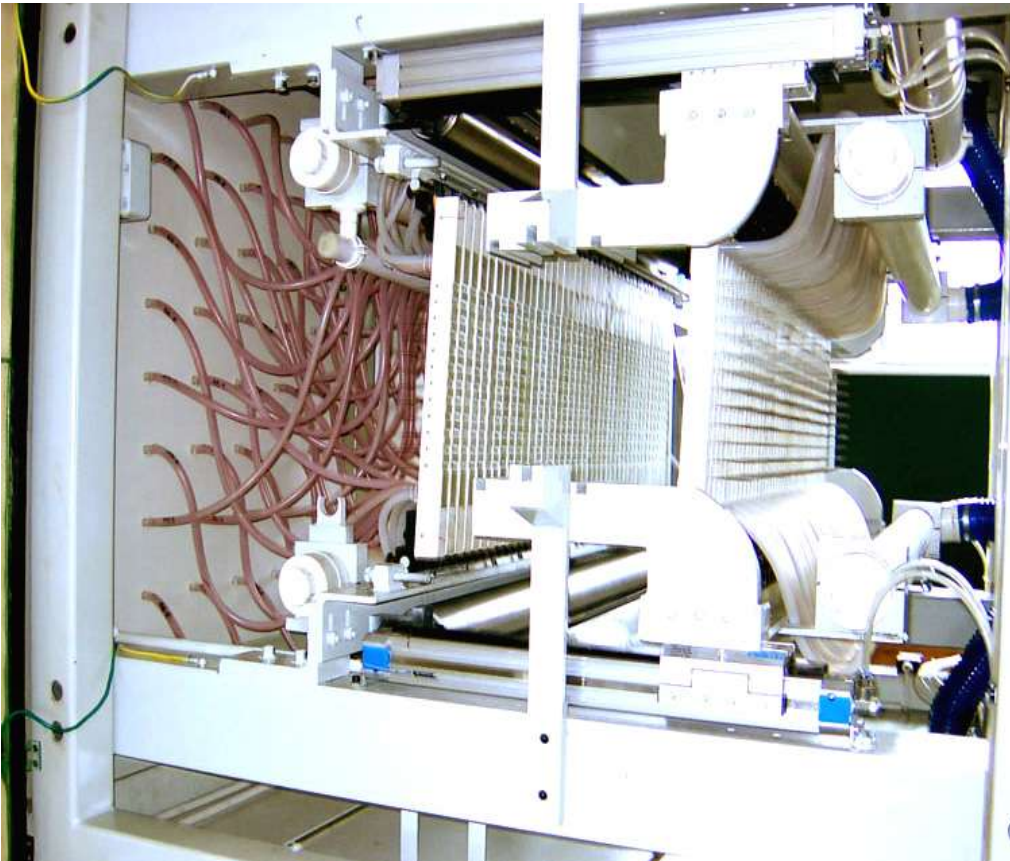
The Perforation machine PS-1200 is build and using for the electrostatic perforation of Plug-Wrap paper webs up to 1150 mm, porosity ranges between 500 - 2000 C.U. and web speeds up to 250 m/min. The perforated Plug-Wrap paper bobbins, here up to 40 bobbins, needs high ventilation grads around and for the cigarette filters of the cigarette manufacturers.

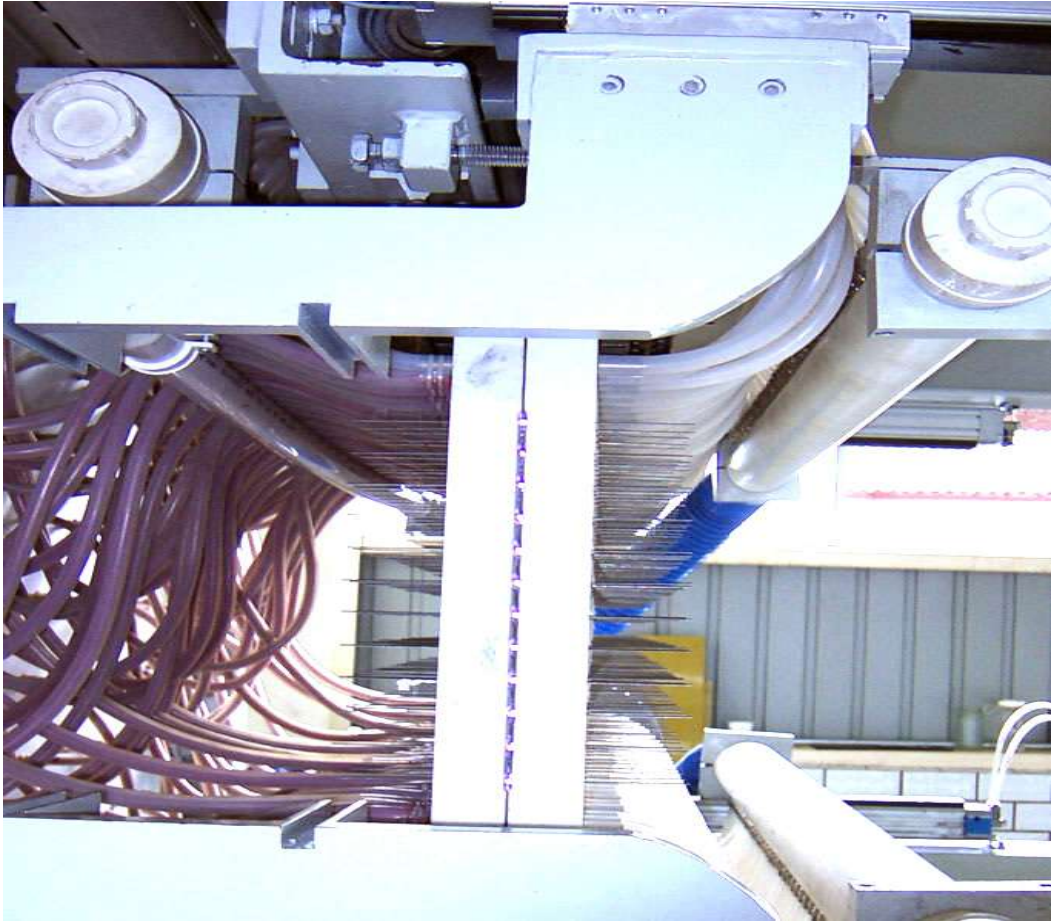
3.1 The whole PS-1200 system consists of following main units :

- Rewind and unwind stand
- three perforation units A, B and C
- three electronic cabinets A, B and C - three high-voltage transformer boxes A, B and C
- perforation control unit at control machine panel - porosity control unit at control machine panel









Further information and technical details are summarised in the added specifications of chapter 21 – 24.

3.2 double web path

These new state-of-the-art PS-1200 perforation machine using the advantage of double web path to perforate the opposite running web again with the same electrodes as before.

That means that the perforation power and number of holes increasing advantageously up to 60 % against the single web path.

While three perforation sections are cascaded the perforation power and number of holes increasing immense what allows to generating porosity ranges up to 2000 C.U. in Plug-Wrap paper webs by acceptable web speeds and a very well perforation design.

3.3 description performance

All further contains and detailed explanation of the construction, the base and working principle of the wide-web perforation machine PS-1200 covers all pneumatic and perforation functions, porosity controls, electrode adjustments, electrode pin settings and summarises diverse production advice and maintenance information.

The description is also supplemented by numbered drawings, illustrations for the perforation units, electronics cabinets, high-voltages transformer boxes, views of add-on equipment and perforation results.

4. Safety instructions

A general rule, perforation machines must only be operated by fully trained, skilled staff with strict adherence to the country-specific accident prevention, Health and Safety – HAS - restrictions and furthermore with electronic-technically regulations and guidelines for high voltage equipment. This also especially applies to the service personnel.

- ***All and individual components, circuit boards, high-voltage transformers, electrodes etc. must never be removed or replaced while the system is switched on !***
- ***It is also strictly forbidden to bridge or mechanically clamp safety switches !***
- ***The PS-1200 perforation machine must never be allowed to run unsupervised !***
- ***All EMERGENCY-OFF buttons on the machine panel, in front of the electronic cabinet and around the perforation section needs always a direct access and is to be operated in the event of danger or for immediate stop of the machine !***
- ***The PS-1200 perforation machine must be only used for its herein described production purpose !***
- ***Furthermore all mechanic and electrical setting of the whole perforation system has to remain in the specified ranges !***
- ***Please note and accept all mechanical and electrical signs and advice !***
- ***In case of service : switch-off all main switches and check for off-voltages !***

Furthermore, it should be noted that the supplied components must not be modified or in correctly installed or used.

The manufacturer assumes no product liability in such cases.

Defects and damage resulting from normal wear or from excessive use by the system user or his staff are also not covered by warranty.

5. Three perforation units

5.1 The drawings 1 - 6 showing :

- DWG 1 : side-view of the whole perforation machine PS-1200
- DWG 2 : side-view with machine operator and three perforation sections
- DWG 3 : side-view with the high-voltage transformer boxes on their rear side
- DWG 4 : top view of the three perforation units with all all-over-dimensions
- DWG 5 : side view of the perforation unit with pneumatic box
- DWG 6 : open side view into the perforation section

5.2 Perforation performance

As shown on these drawings each perforation unit A, B or C has a vertical and double path web leading through the centre of the perforation section on which the 40 sets of 12-pins electrode are positioned.

The electrode gap is opening pneumatically with four linear leading bars so that the front electrode bars moving forward in the direction to the pull-up front door on which the machine operator working. The rear side of electrode sets are fixed in their position.

Four safety switches control the closed position of the electrode movement unit and assure safety operation via the interlock function.

5.3 Doors, safety switches and controls

The front pull-up door and two other doors on the left and right hand side assure a fully and easy access to all places into the perforation section. All three doors has the own safety switches which are in serial connected and supplied to the electrical interlock function to each electronic cabinet.

The perforation section includes in their inner room and in all doors noise reduced material for a quiet machine operation and as well with special EMI sealing and groundings a reduced electro magnetic field outside of the perforation unit.

The control of the perforation section includes also two photocells which are positioned on the top left and right hand side to detect any sparking outside of the electrode pins areas in case off wrong high-voltage connection, wrong pin setting etc.

In any case of sparking detection the interlock function getting off and stop the perforation process and the machine immediately.

5.4 Compartments around the perforation units

As to see on the top of the steel frame there are three side-channel compressors placed to supply the electrode air-cooling and air bolster between the opposite running webs. More information are to find in chapter 13.

The catwalk between the perforation units allows a easy and safety operating and handling on all points around the PS-1200 machine.

Each electronic cabinet is placed on the left hand side of the perforation unit and strait connected to them what is showing in drawing 4.

More information and details of them are described in chapter 7.

As drawing 2 and 4 showing the high voltage transformer boxes are fully integrated and rear-side fixed to each perforation units.

Chapter 8 described more details.

5.5 Pneumatic box and optical scanning system

The pneumatic box position and the fully side view into the perforation section is to see in Drawing 5 and 6.

All functions of them are to find under chapter 10.

In addition of the main drawings 1 – 3 there is the optical inline porosity measurement OPSS-1 system provided, located underneath the last catwalk and just before the rewind stand, which allows a fully inline porosity control across and in web direction and a direct feed-back to all perforation control units.

Please request for more information because the OPSS-1 system is not build-in and a option for this described PS-1200 perforation machine.

6. Machine rewind and unwind stands

The unwind and rewind stands of the PS-1200 perforation machine are designed and supplied by the customer.

6.1 Winder performance

Therefore the principle unwind and rewind stands with force the Plug-Wrap paper webs up to 250 m/min including the web tension unit and paper edge guider are only shown in the side view of the main drawing 1.

The paper inlet comes strait form the rewind stand and underneath the first catwalk to the first perforation section A.

After the last perforation unit C the paper web path the provided space of the OPSS-1 control system at the last catwalk and going strait to the unwind stand with the pressing arm and rewind shaft.

6.2 Operation panel

The machine panel, which is positioned on the left hand side of the unwind stand, is not shown on this drawing and includes all perforation and porosity controlling.

In drawing 21 is there top view of the operation plate to see.

7. Electronic cabinet

7.1 Performance and ventilation

Drawing 18 – 20 showing the front and side view of the electronic cabinet and furthermore the top instrument and centre operation plate.

Each of three electronics cabinets A, B and C housing all mains, power supply, perforation control and power stages units and is direct located on the left hand side of each perforation unit A, B and C.

A special ventilation system for the mains, dc power supplies and all power stages are ensured by two passive air inlets on both below sides, four radial fans into the rear door and one big fan on the top forcing more then 2000 m³/h trough the cabinet. All air inlets working without any filter mats.

A special front glass door allows a direct viewing to all relevant functions, compartments and components. This is also to see from the machine operation panel.

7.2 19"- racks, circuit boards, power modules

The 19" racks 1 – 5 including all power stages PM-IPM-004 for 40 perforation channels and the 6th rack the power supply of +12V/5A, 5 pieces of logic boards LC-IPM-003 and 2 pieces of interface circuit boards IN-IPM-005. The drawing 18 showing all their plug-in positions.

Small red LED's on each front plate of the power modules PM-IPM-004 signalling their active status of the IGBT collector fuses which are integrated on the rear doors of the high-voltage transformer boxes. See chapter 8.

The five LC-IPM-003 circuit boards allowing with their front switches and red LED's – eight on each of them – via the power modules PM-IPM-004 a manual test or normal operation with switch on/off function for each of 40 perforation channels on each perforation unit.

It means that each perforation electrode set with their 12-pin are switch able with this function. The small red LED at the front plate of IN-IPM-005 signalling the okay status for all of 40 collector fuses of the power modules.

7.3 Mains, power supply, 300 V/DC inter circle voltage, cables

On the right hand side plate is the main power switch and emergency stop placed.

The internal power supplies generating the 230V/DC control voltage, two big main transformers with their rectifier devices for 2*300V/DC/20A inter circle voltage which are supplied with their cables and protection tubes next to the high-voltage transformer box.

All main fuses, fan fuses, power supply fuses, control and power relays for the perforation control, three side-channel-compressors, perforation on/off, interlock and safety devices are placed on the rear side montage plate.

40 single coax-cables of each power-modules PM-IPM-004 are connected and leaded through protection tubes to the primary coils of all 40 high-voltage transformers HV-700-A which are plug-in the transformer box.

7.4 Top instruments plate

Drawing 19 showing the top instruments plate with :

- analogue voltage instrument 0 – 500 V/DC for the first 300 V/DC power supply
- analogue current instrument 0 – 20 A/DC for the first 300 V/DC power supply
- analogue voltage instrument 0 – 500 V/DC for the second 300V/DC power supply
- analogue current instrument 0 – 20 A/DC for the second 300 V/DC power supply

7.5 Centre control plate – signal lamps

Drawing 20 showing the centre plate with the signal lamps for each perforation unit :

- control voltage on
- interlock lines on
- circuit board interlock lines on
- side-channel-compressor on
- all safety switches open/close
- electrode unit open/close
- electrode air cooling pressure and photocells on/off
- fault of thermo relays of side-channel-compressors and perforation
- operation hour counter for perforation on/off
- actual inner room temperature of the cabinet with a switching limit by 40 °C – in a case over temperature it would be open the interlock circle

All main functions of the PS-1200 perforation system are controlled from the machine control panel and their functions are visualised on each remote controlled display plate on each electronic cabinet A, B and C.

8. High-voltage transformer box

8.1 Box performance and connection plates

In drawing 15 – 17 are their outer box performance, the high-voltage connection plates and plug-in places for all of 40 high-voltage transformers to see.

Each perforation unit A, B and C has their own transformer box which are integrate on the rear console of them. Special connection plates with their high voltage connectors for all 40 electrode sets closing the front side of the transformer boxes.

It means that this plates with their connection field are just on the opposite of the rear fixed electrode bars of the perforation section what is to see in drawing 6 and 7.

8.2 Rear doors and collector fuses

The common box - split in single box 1 and 2 - has four separate doors with two safety switches for a easy access to all 40 plug-in high-voltage transformers.

On each door are 10 collector fuses – 40 in total - with a size of 5.0A-large integrated and numbered so that the machine operator can find them easily.

As described in chapter 7.2 all IGBT collector fuses are controlled and signalised via small red LED's on each front plate of the Power modules.

8.3 Air inlet and 300V/DC power supply

Two inlet filter on both bottom sides and two air outlet fans on both top sides facilitate a well air convection inside of the common box 1/2 and around the transformers.

Underneath the transformer plug-in plates are two separated 300V/DC condensers units placed to support the 300V/DC inter circle power supply for all IGBT power stages of the 40 PM-IPM-004 modules.

8.4 Plug-in of HV-700-A transformers

Drawing 16 define the places of each high-voltage transformer which are numbered on each plug-in plate as follows – to see it from the rear side :

- left side box 1 : T 1 – T 10
- right side box 1 : T 11 – T 20
- left side box 2 : T 21 – T 30
- right side box 2 : T 31 – T 40

The high-voltage transformer HV-700-A is shown with their electrical connection in drawing 25 and visualised with added pictures.

Their 5 connection pins are not symmetrically so that impossible to plug them wrong. A M5 plastic screw fixed them tied.

Please be carefully for any pull-off or exchanging because they are a little be heavy and needs a carefully handling.

Take attention about the Health and safety instruction in order of chapter 4.

8.5 High-voltage connection of electrode sets

There are 40 pairs of 4 mm connection plugs provided what is shown in drawing 17.

The rule of connection beginning for the perforation electrode set one with 1.1 and 1.2 on the top right side of the plate of box-1 – to see it from the operation side into the perforation section in order of drawing 9.

Follow downward with electrode sets two up to four via 2.1.-2.2, 3.1.-3.2 and 4.1-4.2.

Then the second group with 5.1, 5.2 up to 8.2, the third ones with 9.1, 9.2 up to 12.2, the fourth ones with 13.1, 13.2 up to 16.2 and the fifth ones with 17.1, 17.2 up to 20.2

The other plates of box-2 includes the connection from 21.1 up to 40.2 in order of the same system.

For further information – see the electrical connection of each electrode at drawing 26.

8.6 Special instructions for the high-voltage cables of the electrodes

Please note : the high-voltage wires from the top of each electrode sets has to beginning always first on point X.1. The bottom wires always on point X.2.

Assure a correct plug-in of each 4 mm plug.

Assure always a correct red high-voltage cable leading via the isolated support bars behind the electrode sets.

To avoid any kind cable problem during or with the pin setting procedure.

And in addition that never the high-voltage cables target any metal parts or the electrode pins. Non-observance or failures of high-voltage connections or cable leadings can cause or damage several compartments into the perforation section including the high voltage transformers, power modules etc. which are not covered by the guarantee.

9. Working principle and installation of electrodes

9.1 Design and working principle

The fully design and view of all electrode sets are showing in drawings 6 – 13 and in addition drawing 26 their electrical connection.

Special 12-pin electrodes with their holders in order of drawing 10 – 13 are assembled in a opposite sets performance and vertical position on four leading bars into the perforation section.

At the front to the paper web, the vertically positioned electrode bars having special front strips with transverse grooved covers and contour holes which assure a maximum of pin cooling and perforation dust cleaning.

The flat front position of the electrode pins and the transverse ribs producing a flat through-going area into the perforation gap to avoid any touch and contact of the through running paper web with the electrode pins.

Each electrode has 12 single pins of 1.0 * 80 mm which are pushed into the small inner contact and flashed on the front level as to see in drawing 10.

In these performance 40 electrode sets are installed and distributed across the web width for 40 perforation channels in order of drawing 9.

9.2 Electrical connection and principle

All 12 electrode pins are electrical connected in series to see it together with the opposite electrode bar and the paper web in the gap between. Drawing 26 explains that easily.

As you can see one side of the electrode bar has only jumpers and the other electrode bar on the other side includes two high voltage cables which has to be connected to the rear-side connection board in order of the instructions in chapter 8.5.

That means that always the cable connection side of all electrodes has to installed on the rear side of the perforation section.

All their high-voltage cables has to go in the protected and supported way via the isolation bars to the connection field.

Caution : *This is strictly to assure.*

9.3 Electrode air cooling

The electrode air cooling and dust exhaust system are described in chapter 10.

Caution : *Ensure during installation and production that all plastic tubes has no any fold and that they are always in the right position to assure a continuously air cooling for the small 1.0 mm pins and as well for the electrode bodies.*

9.4 Installation of electrodes

Please note that the fixed hole side of electrode holders are to located on the top leading bars and the slotted hole side of the holders at the bottom leading bars. This is to see for both - the jumper and cable - side of each electrode set. The fixing of the holders on the electrode bars is provided with their inner screws and spring rings to turn them not fully tight.

Mandrel screws ensure a easy fixing of all electrode holders on the leading bars.

For more details about the holder have a look to drawing 13.

Provide all electrode sets in order of the above instructions with the new pins and the holders.

Beginning with the cable connected electrode bars on the right hand side – to see it from the operator front view on the catwalk – of the perforation unit and on the rear leading bars.

Slide them carefully with the fixed holder side on the top and the slot side to the bottom leading bars approx to the centre.

Complete the electrodes in this way up to 20 – on one side. Doing the same procedure from the left hand side of the perforation unit with the electrodes 21 up to 40. On the end there are 40 electrodes on the rear side installed.

Connect all red high voltage cables and plastic pipes in order of the former instructions of chapter 9.2 and 9.3.

Have a look to the side view of drawing 6, 7, and 7a.

Beginning to complete in the same procedure the jumper electrode bars from set 1 up to 40 for the front side.

Caution : *Be carefully with the special SKF ball leading bars and electrode holders to avoiding any damages or crashes of them.*

9.5 Incline position of electrode sets

If all 40 electrode sets are completed, correct fitted and connected then doing a rough alignment in the way of a small incline position of them. Drawing 9 give you an example and showing you the way. It means that all electrode holders on top position has to be move to the left and the bottom electrode holders to the right. On the end all 40 electrode sets are in a incline position to generating a certain area perforation.

Further information are to find on chapter 12.

Caution :

Assure that all electrode sets are aligned on the same line and flat positioned on both outer edges. Furthermore that all holder mandrels are tied. This is easy to see and to touch it by hand.

This condition is later-on very important to ensure a safety high-voltage sparking via the pins and through small electrode gap.

Non-observance or failures can cause or damage compartments into the perforation section including electrodes, high voltage transformers, power modules etc. which are not covered by the guarantee.

10. Electrode air cooling and dust exhaust

10.1 Plastic tubes of electrodes

Two big side channel compressors which are placed on the top of perforation unit supplies the necessary cooling air to all 40 electrode pairs via four separate distribution pipes.

Quick fitters allowing a easy connection of small plastic tubes of 9.0 mm inner diameter to all of 40 electrode sets. It means that each electrode bar has two plastic tubes which has to be connect to the distribution pipe system into the perforation section.

Details are showing in drawing 7 and 7a.

Caution :

Ensure during installation and production that all plastic tubes has no any fold and that they are always in the right position to assure a continuously air cooling for the small 1.0 mm pins and as well for the electrode bodies.

10.2 Control of electrode air cooling

Two air pressure switches on both distribution pipes controlling the electrode air cooling pressure which average range is between 60 – 75 mbar. It is known that the air pressure should be in the same range on all four distribution pipes.

In case of to low air pressure the control interlock and their signal lamp on the electronic cabinet getting off. See chapter 7.5.

10.3 Dust exhaust unit

The dust exhaust units are supplied by the customer which should have an air consumption of around 1800 m³/h for each perforation unit.

Their exhaust connectors are located on both outlet sides on the top of the perforation unit so that the perforation dust can be absorbed easily on both sides of the perforated web.

An operation control of the dust exhaust is provided for each perforation unit.

Normally the exhaust is always in operation with the main switch-on and as well during machine stops in case of roll exchanges, pin settings etc.

Under pressure switches on each perforation unit controlling the minimal pressure of -6 mbar.

An additional air bolster and dust exhaust conduit is located on the top of the perforation section to absorb the in-blowing air directly. This conduit is added to both dust absorption pipes and goes straight out to the top.

Further details are to be found in drawing 6 and chapter 14.2

Caution :

Keep all dust absorption areas always clean.

11. Pneumatic system and functions

11.1 Pneumatic system

Four powerful linear units move the whole front frame with all electrodes bar forward and backward to allow a easy electrode pin setting and gap cleaning.

They are dust protected positioned with two on the top and two on the bottom side and into the perforation section what showing drawing 6 and 7.

All pneumatic functions are controlled from the manual operating box which is located on the left bottom side.

11.2 Pneumatic functions

There main functions are defined in drawing 14.

Following single and common functions are provided :

- forward and backward movement of the whole front frame with their electrodes for paper feed-in or gap cleaning of the electrode gap
- all movements for a rear side electrode pin setting
- all movements for a front side electrode pin setting
- open and close the front pull-up door of the perforation section
- soft-start up's and close down's
- four roll switches for slowly down pressure for opening and closing
- four roll switches reducing the press-on limits during pin settings
- safety switches on each linear movement units assure the interlocks during closing
- main air pressure switch controls the incoming air pressure of 6 bar

All details for the electrode pin settings are explained in the chapter 13.

Caution :

Never open the electrode frames during perforation and production because the interlock lines opening immediately and stops the production process and machine too.

But any damages on the electrodes and other components are not out of questions.

Non-observance or failures can cause or damage several compartments which are not covered by the guarantee.

12. Adjustment of all electrode sets

12.1 Principle procedure for vertical and incline settings

Ensure that all 40 electrode sets completed and roughly fitted with small incline positions in order of chapter 9.5 before you beginning with the register setting.

Assure that all electrode sets are aligned on the same line and flat positioned on both outer edges.

This is easy to see and to touch it by hand.

Remember : each electrode has a dimension of 25 mm width and 12 pins of 1.0*80 mm in the centre line.

Drawing 9 showing the base incline position of the electrode sets.

12.2 Register settings of all electrodes

Check the right register for a perforation of e.g. of 23 mm for a bobbin of 27 mm width what means that each perforated bobbin needs a non-perforated edge of 2 mm on both sides.

The reference paper edge position on the right hand side should be known and then beginning with the electrode set number one on the same side.

Incline the electrode angle in the provided direction for a perforation width of 23 mm. Measure them with e.g. a meter.

After the easy and roughly position of the first electrode sets setting the second electrode set on a distance of 27 mm what is to measure from centre to centre of both electrode holders. Do it in the same way with the other holders on the same electrode set.

Follow this instructions and procedure across the web width up to electrode set number 40.

Caution :

After all assure that all electrode sets are aligned on the same line and flat positioned on both outer edges. Furthermore that all holder mandrels are tied. This is easy to see and to touch it by hand. Non-observance or failures can cause or damage several compartments which are not covered by the guarantee.

12.3 Support instruments

A provided register foil as a pattern with the necessary dimension of e.g. 27 mm bobbin width and 23 mm marks for the whole web width – here $40 * 27 \text{ mm} = 1080 \text{ mm}$ - would be a big advantages for a easy and quick electrode holder setting.

In other words the marks has to beginning from the reference paper edge side with ($27 \pm 2 \text{ mm}$) 2 mm, 25 mm, 29 mm, 52 mm etc.

Please check all marks before you using the register foil for any adjustment and settings.

12.4 Fine adjustment with paper and perforation

There is a fine adjustment of all electrodes necessary to see the perforation areas on the right position at the running paper web.

This to do it and to check it again in order of chapter 15.

In principle, all procedures and instructions are the same for a rough or fine electrode setting.

13. Adjustment of electrode pins

13.1 Principle and slide-in plate

Electrode pin settings are necessary because they burning slowly off depends of loading and operation time. Therefore all electrode pins on each perforation unit needs a re-setting to the flat front position of the electrode strips in a time interval of a minimum of 24 operation hours.

The PS-1200 perforation system with vertical web path using the movement of the front electrode frame and a slide-in plate to do this procedure manually.

In addition with the slide-in plate and their dimension of 1493*260*10 mm they are on both sides two sets of fixing points provided.

One fix slide-in unit is installed on the rear and right hand side of each perforation unit.

On the opposite is a quick lock slide-in unit with two mandrel screws to assemble by hand.

Another vertical slid-in unit is on both sides to the operation front fixed.

This is showing in drawings 7 and 8 and explained in the further chapters 13.2 and 13.3.

Caution :

All slid-in units has a rear and front position for the slid-in plate.

13.2 Rear side pin setting

See before the drawings 7, 7A, 8A and 8C. Doing the following procedure carefully :

- two machine operators or an assistant person for the operator is necessary
- pull off the paper of the gap
- assemble the quick slide-in and vertical positioned unit with two big mandrel screws on the left hand side of perforation unit
- ensure that the quick lock is tied
- using the rear sliding position and handle by two persons the plate carefully to push them across over to the vertical positioned slid-in unit on the opposite
- ensure that the slid-in plate is fixed and in the rear position
- open now the front electrode frame with their pneumatic function
- now the insert plate moves with the whole frame forward and pressing all pins of the rear electrodes out – to the point that the slid-in plate reach the rear side of electrodes
- four roller switches on the linear units limit the pressing power
- let open the electrode frame
- pull-off the slid-in plate and insert them now in the front position
- assure that the slid-in plate is correctly positioned on the vertical holders
- closing now the electrode frame with the pneumatic function
- now all pushed-off electrode pins getting back again in their flash front position with the slid-in plate into the electrode gap
- four roller switches on the linear units limit the pressing power
- if this procedure is right done take-off the slid-in plate very carefully
- ensure that the insert slid-in plate is off ----- within the rear side pin setting finish

Caution :

Handle the slid-units/plate very carefully to avoid any crashes of hands and electrode pins.

13.3 Front side pin setting

See before the drawings 7, 7A, 8A and 8C. A similar procedure for the front side pin setting :

- ensure that the electrode frame is closed
- using the front slid-in unit and handle by two persons the plate carefully to push them across over to the same slid-in unit on the opposite
- ensure that the slid-in plate is fixed positioned
- open now the electrode frame with their pneumatic function
- now the electrode frame moves forward and pressing all pins of the front electrodes out – up to the point that the moving frame with the electrodes reach the insert slid-in plate in their fix position
- four roller switches on the linear units limit the pressing power

- let open the electrode frame
- pull-off the slid-in plate
- open now the electrode frame fully to the end of front position
- insert the slid-in plate in the same front position
- assure that the slid-in plate in correct positioned into the vertical holders
- closing the electrode frame with the pneumatic function
- all pushed-off electrode pins getting now back again with the slid-in plate in their flash front position
- four roller switches on the linear units limit the pressing power
- if these procedure is right done take-off the slid-in plate very carefully
- ----- within the front side pin setting finish

Caution :

Handle the slid-units and plate always very carefully to avoid any crashes of your hands and electrode pins.

14. Paper web path

14.1 Principle web path through the machine

A fully overview for the whole web path through all perforation sections are explained in the drawings 1, 2 and 6.

In principle it looks like a part of a gravure printing machine.

- the paper leading beginning from unwind stand and their edge guider
- follows the way underneath the first catwalk behind the perforation unit A
- going strait into the perforation section A in the described way of double web path
- path the opened gap of perforations electrode sets
- upward to the divert rollers on the top and back in the opposite direction through the open gap perforation to the bottom divert roller of unit A
- the web follows the way underneath the operation catwalk of unit A to the feed-in of the perforation unit B
- going ahead in the same way as before for unit A
- coming-out at unit B and path the operation catwalk for unit B
- coming-in at unit C and the web follows the way as well as before
- coming-out at unit C and path the operation catwalk for unit C
- which is the space and future using of the OPSS-1 optical porosity scanning system
- going strait with the web to the rewind stand and the rewind core

Caution :

The electrode frames of all three perforation sections A, B and C has to be opening before a web in-coming.

Furthermore that all covers of the catwalks are to opening too.

Assure the safety instructions and avoid any crashes.

14.2 Electrode gap and air bolster between the webs

A double web path on each perforation unit A, B and C facilitates a very high perforation power together with a high rate of number of holes into a certain perforation area. In means that the pre-perforated web coming back to the same perforation section in a opposite direction and this three times into three separate perforation sections.

This new process generating a MEGA perforation power for porosities up to 2000 C.U. The electrode gap is fixed by 1.6 mm in the closing position so that the in- and out-coming web has upward and downward to through this gap.

To avoiding of any web touching is a special air bolster between the opposite running webs necessary.

With the right pre-pressure of the air in-blowing the bolster generating a very small distance or around 0.5 mm between the opposite running and also across the webs width.

A small side-channel-compressor on the top of perforation unit supply the air by around 40 mbar to the blowing-in nozzle which is located directly to double web in- and our coming on the bottom part of perforation section. Further details are shown in drawing 6. As described in chapter 10.3.

14.3 Light running rollers

All uses 80 mm rollers are light running AL rollers to assure a minimum of web tension by a very precise web leading. Ensure all the time that all in- and out-coming webs always exactly positioned and equal covered with their edges.

Normally the web position is to keep into a range of +/- 0.1 mm.

This is a fundamental condition to keep the perforation areas on each perforation unit A, B and C always in the same and provided position. And furthermore to allows a quick increasing and decreasing of the web during starting and stopping of the machine by speeds up to 450 m/min

Caution :

Avoid any kind of paper folds or other leading disadvantages.

Keep all the time the rollers clean.

15. Operating the machine

15.1 Machine controls

In order of the short description under chapter 6 about the unwind and rewind units as well with the added drawings they are the main operation functions to find in the machine manual which are supplied by the customer.

In further chapters are some additional machine functions are descript.

15.2 Emergency stop

In any case of emergency stop or if one button around the machine, at each perforation unit or at the electronic cabinet was switched-off the fully line getting off.

A restart with the blue button reset at the operation panel is necessary.

16. Perforation control – machine control panel

16.1 Electrical conditions of interlock lines

Drawings 20 - 22 support the further explanations of chapter 7.

All base electrical functions of interlock lines on each perforation unit A, B and C and their common functions to switch-on are define as follows :

on each perforation unit A, B and C :

- main switch on
- all circuits boards are plug-in
- 12V/DC power supply is existent
- no over-temperature into the cabinet

as common functions from the machine panel :

- operation panel main switch on
- no emergency stop switched off
- 12V/DC power supply of the operation panel is existent

- system air supplying of 6 bar are correct
- control voltage is on
- central dust exhaust system in on
- under pressure switches on each perforation unit are switched on
- further interlocks for the perforation function : paper break control, no fault at main drive control unit

Caution :

The most of these status are signalised with green lamps on the central control plate on each cabinet A, B and C as to see on drawing 20.

16.2 Control button fields on the machine operation panel

As to see in drawing 22 there are four fields of control button and signal lamps are to find :

- main field with principle functions as emergency, control voltage, reset emergency, interlock A, B and C
- production/test without paper or with paper
- Auto-start, Auto-stop
- three fields for side-channel-compressor on/off for unit A, B and C
- and in the same field for perforation on/off and Perforation start/stop

Below you find the switching conditions and details.

16.3 Electrical condition for side-channel-compressors on/off

All control buttons and lamps are to see in drawings 21 and 22.

As define for the principle functions before now the side-channel-compressors are able switch-on and off as follows :

- interlock of machine panel is okay
- interlock of all three electronic cabinets A, B and C are okay
- thermo relays for the side-channel-compressors and perforation are not switched-off
- phase relays control of perforation mains are okay
- all three safety door switches on each perforation unit are closed
- the safety switch of the high-voltage transformer box on each unit is closed
- the electrode frame with their four single switches are closed on each perforation unit
- ----- **switch production/test : in the position ----- without paper**
- switch-on the side-channel-compressors for unit A with the SCC-A start button
- ----- **the side-channel-compressor sets starting in time sequences automatically**
- ----- **this in the same way for unit B and C**
- **separates switching-off is provided with button SCC-off**

Caution :

Each perforation unit with the side-channel-compressor sets has their own air-pressure switch controls on both sides of the distribution pipe as well as decrypted in chapter 10.2 and 10.3.

All other interlock lines controls the actual and running functions.

16.4 Electrical conditions for perforation on/off – for test without paper

All control buttons and lamps are to see in drawings 21 and 22.

As define before for the side-channel-compressors now the perforation units A, B and C are able to switch-on and off as follows :

- **pre-condition as 16.1 and 16.2 are okay and done**
- the side-channel-compressors for each unit A, B or C is on and in operation
- **remember : switch production/test in the position ----- without paper**

- **no paper into the electrode gap**
- the electrode air pressure on each perforation unit is correct e.g. 60 mbar
- both photo cells detecting no wrong sparking outside of the electrodes
- ----- **start perforation at unit A**
- the perforation power supplies and drivers starts in time sequences automatically
- each perforation drivers has a short time delay after the power supply on and in the opposite same way to switch them off
- **perforation unit A perforating/operating and all interlock lines control them by themselves**
- **going in the same way ahead for perforation unit B and C**
- ----- **switch-off : at any time possible for each perforation unit A, B and C**

Caution :

Each perforation unit has their own interlock line and controlling during running. In case of faults or switching-off the fully line functions getting off immediately.

Never open electrode frames or other interlock lines during perforation and machine running. The PS-1200 system is controlled with a lot of added interlock functions to keep the system safe as possible. But there no out of questions that something can getting wrong during any kind of interrupting which by non-observance or failures can cause or damage several compartments which are not covered by the guarantee.

16.4 Electrical conditions for perforation on/off - with paper

All control buttons and lamps are to see in drawings 21 and 22.

As define before the perforation units A, B and C are able to switch-on and off as follows :

- **pre-condition as 16.1 and 16.2 are okay and done**
- **paper web is into the machine**
- **switch production/test in the position ----- with paper**
- **start the rewinding machine**
- **let running the paper web slowly**
- the minimal speed indicator switch on by e.g. 25 m/min – tooth disc on the first roller at perforation unit A
- **switch auto-start/stop - push start : all side-channel-compressor sets for each unit A, B or C starting-on automatically**
- all side-channel-compressor sets getting in time sequences in operation
- all electrode air pressures on each perforation unit working correctly e.g. 60 mbar
- all photo cells detecting no wrong sparking outside of the electrodes
- automatically switching-on of all perforation power supplies and drivers in sequences
- **perforation unit A, B and C perforating/operating and all interlock lines control them by themselves**
- **start the machine to the production speed after all these procedures of during them**
- ----- **switch-off : at any time possible by : Auto-start off**
- ----- **or machine : stop function**

Caution :

Each perforation unit has their own interlock line and controlling during running. In case of faults or switching-off the fully line functions getting off immediately.

Never open electrode frames or other interlock lines during perforation and machine running.

The PS-1200 system is controlled with a lot of added interlock functions to keep the system safe as possible.

But there no out of questions that something can getting wrong during any kind of interrupting which by non-observance or failures can cause or damage several compartments which are not covered by the guarantee.

17. Porosity control – machine control panel

17.1 System configuration, signal and power flow of PS-1200 system

In drawing 23 is the fully system configuration and power flow with all details are showing.

Below a short description to the main function blocks and further information :

- a frequency unit IPM-FR-001 generates the sparking frequency between 500 - 6000 Hz
- another way to generate the frequency is a certain relation to the web speed has a configuration with the Tacho generator, DC/DC and U/F-converter
- the OPSS-1 – optical inline porosity scanning system - is to see as an option
- both frequency lines are choose able and provided to supply 40 single pulse stages which are integrate at five circuits boards IPM-PW-002 – here PWM 1 – 40 for all perforation channels in all units A, B and C
- behind them the signal flow is distributed in three lines to cabinet A, B and C with their power supply of 300V/DC
- each signal lines has their own logic switches with IPM-LG-003, interface circuit board IPM IN-005 and the single driver and power stage of IPM-PM-004
- each power module IPM-PM-004 supplies the output to the high-voltage transformer 1 - 40 to each perforation unit
- and each high-voltage transformer HV-700-A at any ones of 12-pin perforation electrode set supplies

17.2 Frequency control

Drawing 21 showing the main functions and circuit boards into the top 19” racks at the machine operation panel.

Their functions are easy to understand and define as follows :

- the common frequency and is manual controlled with a ten-turn potentiometer at the front plate of IPM-FR-001
- as well the certain relation to the web speed via the Tacho generator, DC/DC and U/F-converter
- in addition to both ten-turn potentiometers are two small switches at their front plate provided for :
- testing on/off and
- choosing of common fix frequency or speed synchronised operation
- the integrated frequency counter showing always the actual frequency

Caution :

Never switch-over this functions during perforating. The PS-1200 system is controlled by internal functions to keep the system safe as possible. But there no out of questions that something can getting wrong during any kind of interrupting which by non-observance or failures can cause or damage several compartments which are not covered by the guarantee.

17.3 Pulse-width control

In comparison of that drawing 24 showing the pulse-width setting into the second 19” racks at the machine operation panel.

Their functions are define as follows :

- five circuit boards of IPM-PW-002 are behind the front plate
- they generating 40 single pulse width channel which potentiometers are integrate on the front plate
- their push-up and push-down functions allows a across-over view of the real paper web width
- this performance obtains a very well visualisation to each potentiometer position and their perforation power control to each perforation electrode set across the real web width
- that means : low position – lower power ----- high position – higher power
- **this is the way to control and match the porosity for each perforation channel – each certain perforation area – for the common units A, B and C**

Caution :

The beginning and standard position is to see in the centre line.

Minimum or maximum positions cause no damages but it should avoid under the background of control ranges.

17.4 Porosity control – fix or web speed synchronised frequency

In order of the frequency and pulse-width control explanations of chapter 17.2 and 17.3 the porosity, hole sizes, hole densities and perforation power are defines as following :

- lower pulse-widths with the sliding up/down potentiometers generating smaller holes
- higher pulse-widths with the sliding up/down potentiometers generating bigger holes and higher perforation power
- all pulse-widths are adjustable with the 40 sliding up/down potentiometers for each perforation channel and electrode sets between 9 μ s – 18 μ s of each spark discharges
- lower frequencies generating lower hole densities and lower perforation power
- higher frequencies generating higher hole densities an higher perforation power
- the frequency range is provided between 500 Hz up to 6000 Hz as a repetition rate for the single sparks
- as described before the frequency setting is provided with a ten-turn potentiometer for a fix-frequency operation and otherwise with another ten-turn potentiometer for a web speed synchronised operation
- in both operation modes : the frequency range remains between 500 – 6000 Hz

Caution :

Within the three perforation units and their each double web path the PS-1200 perforation machine are able to generating very high hole density rates up to 200 holes/cm² and high porosities up to 2000 C.U.

In other words the pre-perforated plug-wrap paper web path the next perforation sections B and C what obtains a very high effectiveness of the whole production process.

17.5 Base porosity setting – manual frequency operation

Several steps are necessary to choose the right parameters and doing the porosity settings.

Step 1 :

- setting as a reference all sliding up and down potentiometers in the centre position
- switch at IPM-FR-001 : **manual frequency operation**
- setting by **manual frequency operation** the ten-turn potentiometer to position 5.00 – etc. frequency counter showing 3000 Hz
- start the perforation machine with the plug-wrap web in the described way
- using the perforation power formula in order of chapter 18 to calculate the web speed roughly
- stop the machine and check all perforation areas and their registers in order of chapter 12

Step 2 :

- re-adjust and match the perforation areas in the right way
- start the machine again with a certain speed
- check the average porosity for certain perforations – etc. 6 perforated areas

Step 3 :

- if the porosity is still to low : turn the frequency higher to the rough calculated increasing; etc. 20 % or 40 % more – the frequency counter shows around 4200 Hz
- start the perforation machine and check the porosity again

Step 4 :

- if the average porosity level is still to low – increasing the frequency to the target perforation power – the position 9.0 and frequency of around 5400 Hz should be the practical maximum to control them later-on with a fine tuning
- on the end - match the average porosity via the web speed to the target level

Step 5 :

- doing the fine matching for each perforation area with the pulse-width function via the 40 sliding potentiometers

Further information are to find in the chapter 18 – production.

17.6 Base porosity setting – synchronised web speed frequency operation

Do it in a similar way for the synchronised web speed frequency operation :

Step 1 :

- setting as a reference all sliding up and down potentiometers in the centre position
- switch at IPM-FR-001 : **synchronise web speed frequency operation**
- setting by **synchronised web speed frequency operation** with the ten-turn potentiometer - frequency relation to the speed - to position 5.00
- start the perforation machine with the plug-wrap web in the described way
- using the perforation power formula in order of chapter 18 to calculate the web speed roughly
- stop the machine and check all perforation areas and their registers in order of chapter 12

Step 2 : --- only for new settings of perforation area necessary

- re-adjust and match the perforation areas in the right way
- start the machine again with a certain speed
- check the average porosity for certain perforations – etc. 6 perforated areas

Step 3 :

- if the porosity is still to low : turn the frequency relation higher to the rough calculated increasing; etc. 20 % or 40 % more – the frequency counter shows around 4200 Hz – if the machine running
- start the perforation machine and check the porosity again

Step 4 :

- if the average porosity level is still to low – increasing the frequency relation to the target perforation power – the position 9.0 and frequency of around 5400 Hz should be the practical maximum to control them later-on with a fine tuning

Step 5 :

- doing the fine matching for each perforation area with the pulse-width function via the 40 sliding potentiometers

Further information are to find in the chapter 18 – production.

18. Production

18.1 Calculation of perforation power

In order to the explanations of chapter 17.5 and 17.6 and the add specification the perforation power is roughly to calculate as following :

web speed = perforation power (C.U.*m/min) / porosity (C.U.)

The perforation power factor of the PS-1200 is limited by 120.000 C.U.*m/min

This allows a web speed calculation of two examples :

target porosity : 500 C.U. ----- web speed $120.000 \text{ (C.U.*m/min)} / 500 \text{ C.U.} = 240 \text{ m/min}$

target porosity : 2000 C.U. ----- web speed $120.000 \text{ (C.U.*m/min)} / 2000 \text{ C.U.} = 60 \text{ m/min}$

Caution :

Calculate roughly in order of this formula the perforation power and using their results for the pre-production setting of web speed.

Follow the instructions of the pre-pulse wide and pre-frequency settings in order to chapter 17.3 – 17.6.

18.2 Production beginning – perforation area setting

There are several steps to adjust the perforations areas to necessary production range and quality level :

Step 1 :

- assure the right high-voltage connection of all electrode sets in order of chapter 8.5 and 9.2
- assure the position and flat alignment of all electrode sets in order of chapter 12.1
- ensure the electrode pin setting procedure in order of chapter 13.1 – 13.3
- close the electrode frames of all perforation units A, B and C with the pneumatic function as described in chapter 11.1 and 11.2
- choose the right operation mode : manual frequency and web speed synchronised operation in order of chapter 17.4 – 17.6
- using the prepared register foil or others in order of chapter 12.2
- **reduce the web speed for perforation area checking**

Step 2 :

- start the machine with all electrical functions for the side-channel-compressors and perforation on/off
- look to all instructions of chapter 16.1 – 16.4
- **do it for perforation unit A**
- stop the machine and check the position of perforation areas for each bobbin
- do it in the described way of chapter 12.1 . 12.3
- if necessary : check it again to match the perforation areas in the provided range and position

Step 3 :

- start the machine with all electrical functions for the side-channel-compressors and perforation on/off in order of chapter 16.1 – 16.4
- **do it for perforation unit B**
- stop the machine and check the position of perforation areas for each bobbin
- do it in the described way of chapter 12.1 . 12.3
- if necessary : check it again to match the perforation areas in the provided range and position

Step 4 :

- start the machine with all electrical functions for the side-channel-compressors and perforation on/off in order of chapter 16.1 – 16.4
- **do it for perforation unit C**
- stop the machine and check the position of perforation areas for each bobbin

- do it in the described way of chapter 12.1 . 12.3
- if necessary : check it again to match the perforation areas in the provided range and position

Step 5 :

- **setting now the production speed in the roughly calculated range**
- start the machine with all electrical functions for the side-channel-compressors and perforation on/off in order of chapter 16.1 – 16.4
- **do it with all perforation units A, B and C**
- stop the machine and make a final check of perforation areas and their positions
- do it in the described way of chapter 12.1 . 12.3
- if necessary : check it again to match the perforation areas in the provided range

Caution :

Ensure a precise web leading and web path through all perforation units with the target that all paper edges covering each other during incoming and out coming in order of chapter 14.1 – 14.3.

Please note that the perforation areas at each bobbin has to being in their geometrical position with a maximum tolerance of +/- 0.3 mm.

See data of specification.

18.3 Production beginning – porosity setting and fine adjustment

If the perforation area settings are finished then beginning with porosity setting.

Have a look backward to the chapters 17.1 – 17.6 and ensure the pre-settings.

Going ahead in following steps :

Step 1 :

- start the machine with all electrical functions for the side-channel-compressors and perforation on/off in order of chapter 16.1 – 16.4
- **do it with all perforation units A, B and C**
- stop the machine after approx. 200 meters and check the porosity of each bobbin with the static measurement equipment as like Borgwaldt A9 or A10, Sodimat or Filtrona
- using the hints in order of chapter 17.4 and 17.5
- using the out printing of the static results or write down the results by hand

Step 2 :

- if all porosities with their average level to high :
increase the web speed up to 5400 Hz (maximum) in the **manual operation mode**
or in the **web synchronised operation mode** reduce the ten-turn potentiometer in the same level difference before and then increase the web speed
- if all porosities with their average level to low :
decrease the web speed in the **manual operation mode**
or in the **web synchronised operation mode** decrease the ten-turn potentiometer in the same level difference before and then decrease the web speed
- using the advantage to bring the highest and lowest porosities for some perforation channels down or up with the slide-pulse-wide potentiometer

Step 3 :

- start the machine again
- stop the machine after approx. 200 meters
- check the porosity of all perforation channels = bobbins

Step 4 :

- doing a fine adjustment in order of step 1 and 2
- furthermore a rough porosity setting of each perforation channel with the pulse-wide slide potentiometers

Step 5 :

- all rough porosity setting should be done after three starts and stops
- let running the machine up to approx. 500 meters
- stop the machine again and make a final porosity check

Step 6 :

- doing a fine frequency and pulse-wide setting – if necessary
- beginning with the first production length e.g. up to 5000 meters
- tune the perforation channels in the provided way and range

Step 7 :

- now the porosities should be and lower in the ranges of :
≤ 500 C.U. ----- +/- 40 C.U.
501 - 1000 C.U. ----- +/- 80 C.U.
1001 - 2000 C.U. ----- +/- 120 C.U.

Caution :

Keep all pulse-wide slide potentiometers in the medium range and around the centre.

Using the ten-turn frequency potentiometers for a fine tuning too.

Adjust only the perforation channels which are out of the provided range or has a trend to getting up or down.

In case of single perforation channel testing for each perforation unit choose the small switches on the front plates of IPM-LC-003 in order of chapter 7.2

18.4 Running production – fine adjustments and controlling

During production it can happen through influences of paper thickness, paper consistency, perforation area getting wider or smaller, or others that the porosity increasing or decreasing in smaller or wider ranges.

The OPSS-1 optical inline porosity measuring system compensating all porosity changes completely and keep them constant in a very small variation. This system is not integrate into the PS-1200 perforation machine and an option which details are to find in the specification and chapter 5.5.

Under this background the porosity variations are to eliminate manually.

Normally the porosities of each perforation channel should remain into the ranges of :

- ≤ 500 C.U. ----- +/- 40 C.U.
- 501 - 1000 C.U. ----- +/- 80 C.U.
- 1001 - 2000 C.U. ----- +/- 120 C.U.

Caution :

If not - using the pulse-wide slide potentiometer to bring them up or down.

But keep all pulse-wide slide potentiometer in the medium range and around the centre.

Otherwise if the porosity level increasing or decreasing for all perforation channels - using the frequency or frequency relation ten-turn potentiometer for a fine tuning and keep the average porosity level to the provided target.

Control the porosities of each perforation channel and as well the perforation areas during each machine and production roll stops.

Correct the perforation areas in the provided way if necessary.

See chapter 12.1 up to 12.4.

18.5 Running production – input current, collector fuses, single switches IPM-LC-003

Keep attention to following points :

- look after the chapter 7.2 – 7.5 and ensure that all collector fuses of each power modules IPM-PM-004 are operation. Observe the small red LED's at their front plates and as well at the IPM-IN-005.
- the 300-DC input current of each perforation channel is limited by around 800 mA by 6000 Hz

- at the top front plate each 20-A-meter shown the sum current of 20 switched-on perforation channels = $20 * 0.8 \text{ A} = 16 \text{ A}$ maximum
- both inter circle voltmeters indicate the power supply in a normal range by 300 – 320 Volt
- the normal DC input current of the dual power supply remains down to 15 Amps
- using 5A large collector fuses in the size of 6.3 * 32 mm which are integrate in the rear doors of the high-voltage transformer boxes
- exchanges them if the getting altering
- a getting-off of one collector fuse cause a third perforation power switch-off at each perforation channel
- using the single switches at IPM-LC-003 circuit boards for testing and/or to switch-off the not uses perforation channels in case of smaller web wide and others

Caution :

Ensure that any time a electrode sets is connected on all the high voltages connectors if the small single switches at IPM-LC-003 are on or off.

By non-observance or failures it can cause or damage power modules, electrode sets, high-voltage transformers, high-voltage connections and others which are not covered by the guarantee.

18.6 Running production – electrode pin deposit formation – joined paper web

The perforation circuit avoids any deposit formation on the end of the pins of electrodes. Depending on paper quality increased deposit formation with a web contact may occur after long production terms of e.g. 50.000 meters and by high porosity levels.

This can be avoid with the right position of double web path on each perforation unit and furthermore with the correct setting of air-bolster between in the in- and out coming web.

See advices in chapter 4.2.

This in addition with electrode air-cooling pressure which advices are to find in chapter 10.2.

Otherwise it is known that by production roll changing the joined paper web should getting through the perforation gaps if the electrode frames are opened before. During this opening and closing time the electrode pins with their possible deposits can getting nearly off.

Caution :

Take the dust exhausting areas and the dust absorption pipes always clean.

For more information have a look to chapter 10.3.

18.7 Running production – electrode pin setting intervals

In order of all instructions of chapter 13.1 – 13.3 all electrode pins needs a re-setting time interval of 24 operation hours.

The operation hours are to read at any time on the counter into the electronic cabinet at each perforation unit A, B and C. It means that is the operation time of the perforation.

It would be an advantages to do it during a production roll changing so that there is no any additional machine stop necessary.

Caution:

Note that the electrode pin setting can cause small perforation position and as well porosity changes what is to compensate with a fine tuning with the frequency or pulse-wide.

Normally the average porosity increasing by 3 up to 5 % after the pin setting.

This can be compensate with a lower frequency or higher web speed during the first 500 or 1000 production meter.

Practise experiences said that the pin setting effect getting off after a certain time.

Therefore it is an advantage to check the perforation positions and porosities for all perforation channels after a short production length, if it possible.

React in the provided way as described in chapter 18.

19. Quality control

19.1 Quality control requirements

All quality requirements are pass-forward from the production management in accordance with the specifications and the availability of register foils for the plug-wrap material.

Below a short list of qualities for the perforation of plug-wrap papers which are provided to further supplement the production requirements to achieve their compliance with the PS-1200 perforation machine.

19.2 Logistics and roll quality

- roll supply, identification, protection and safety storage
- winding quality, length of the roll, core size and inner diameter
- paper edge position to the edge of the core
- plug-wrap paper quality
- dirtying and folds or any other defects

19.3 Perforation

- perforation position at each bobbin
- perforation area wide at each bobbin
- porosity in C.U. at each bobbin
- average porosity level
- deviation of the porosity and c.v. in %
- perforation visibility
- visible perforation defects
- perforated paper sample for the machine operator
- perforated paper sample for the quality control

19.4 Production data and working place

- production sheets
- quality control sheets
- cleanness of working area
- cleaning possibilities
- work table and lighting
- transfer and handling of all paper samples to the quality control department

20. Clean-up and maintenance

20.1 Controlling and cleaning during production

Keep going following hints during production which are descript in the chapters before :

- all collector fuses of the power modules IPM-PM-004 are okay – see small red LED's at their front plates and as well at the IPM-IN-005 – see chapter
- keep clean the dust exhausting areas and absorption pipes into the perforation section
- any kind of dust or glues on each rollers
- electrode sets free of perforation dust and possible deposits by air-pistol or a soft brash while the electrode frames are open
- all high voltage cables free of perforation dust by air-pistol
- all air inlets and outlets of the electronic cabinets has to be free all the time
- in the same way at all high voltage transformer boxes
- as well all air inlets of side-channel-compressors

- all electrode ball leading bars has to be free of dirtying, rust, damaging etc.
- doors and their EMI sealing at all perforation units A, B and C
- inner rooms of perforation sections
- both photo-cells into the perforation section and their free left and right view next to the perforation gap
- clean the four linear movement devices into the perforation section
- slide-in plate and their assembling devices
- check roughly the length and strait performance of all electrode pins which are normally 1.0 * 80 mm
- avoid any twisted electrode pins – renew them if necessary

Caution :

Assure the advices of chapters 9.1 – 9.5 as well as 13.1 – 13.3

20.2 Cleaning of electrode sets into the perforation units

After approx. 100 operation hours and depends on perforation power loading, deposits, etc., a cleaning with soft brush – no sharp tools - in the vertical direction of all electrode sets in all three perforation units A, B and C should be carried out whilst the exhauster is running.

The cleaning procedure can be assisted, made much easier and more efficient by using of compressed air pistol.

Caution :

Note the important advices of former chapters.

Renew electrode pins which are too short.

20.3 Remove and cleaning of all electrode sets

After approx. 4 months or around 1500 operation hours all electrode sets has to removed and thoroughly cleaned-up. To avoid any longer machine stop is to do it over a weekend.

Perform it the following procedure :

- make black mark on the ball leading bars for the first and last electrode position which would an advantages to positioned them precisely after cleaning
- remove all electrode sets completely with their holders
- pull-out all electrode pins
- clean carefully the electrode bodies with a hard brush to remove the worst deposits and dirtying
- check and clean carefully all red high voltage cables and their 4 mm connectors – renew if necessary
- check all air inlet plastic tubes to assure no any fold or damages – renew if necessary
- prepare a cleaning cold water bath with a normal domestic cleaner
- wet-clean each electrode body with the brush and then thoroughly blow them free with a air pistol
- drying all electrode sets during around 12 hours and if possible, with the assistance of a heater up to max. 80°C
- after that reassemble all electrode bodies with new pins and fit correctly in all three perforation sections A, B and C

20.3 Maintenance

Fill-up a current service list and obey following instructions for the maintenance :

- **clean and protect weekly** all four ball leading bars and electrode holders with a small oil film or suitable spray
- **ones a week :** blow-out the three electronic cabinets with the air pistol whilst all fans running and blowing-out all dust

- **ones a week** : blow-out the three high voltage transformer boxes with the air pistol whilst all fans running and blowing-out all dust
- **ones a months** : doing a visual check to the electronic cabinets, high voltage transformer boxes and all high-voltage connection boards to ensure a fully safety operation
- **ones a months** : doing a visual check to all high-voltage transformers HV-700-A which are fixed with a M5-plastic screw
- **ones a months** : check all main and other fuses and their fixing caps
- **ones a months** : check the dual 300V/DC power supply, their capacities and tied DC cables
- **ones a months** : check the control function of all emergency stop bottoms and electrical function
- **ones a months** : check all safety switches of all side and fronts doors and their electrical functions at all three perforation units A, B and C
- **ones a months** : check all photo-cells and safety functions with a hand lamp or in another way – using the single channel switch-off functions at IPM-LC-003
- **ones a months** : check all limit switches of the linear movement devices
- **ones a months** : check all control buttons and control lamps
- **ones a months** : check all pneumatic functions
- **ones a months** : check the oil filter of the system air supply
- **ones a months** : depends on dirtiness level a complete replacement of filter units of the main dust exhauster is necessary; follow the instructions of the customer

Caution :

Using the original parts for the PS-1200 perforation machine.

Non-observance or failures can cause or damage power modules, electrode sets, high-voltage transformers, high-voltage connections and others which are not covered by the guarantee.

21. Additional information

21.1 Spare parts

The PS-1200 perforation machine has a certain spare parts contingency which makes replacement and spare parts available for a lengthy production time.

Checking from time to time the replenishment and order new ones from the original supplier.

Keep your spare parts all the time in the best technical performance and a quick access.

The most parts of the spare parts contingency will never or only rarely be needed. But in some countries the delivery of spare parts could taking more time or one week and force non-availability of the machine. Therefore a number of special parts have been included in the spare parts package in order to avoid such a situation.

Caution :

Using original spare parts for the PS-1200 perforation machine.

Carry-out a current list for a better overview and order them early enough in order of the spare part list. Non-observance or failures can cause or damage power modules, electrode sets, high-voltage transformers, high-voltage connections and others which are not covered by the guarantee.

21.2 Machine operator trainee

Within the PS-1200 commissioning and production beginning the machine operators are trained by IPM.

From time to time keep your machine operators fit in trainee and refresh their technical and production information about the PS-1200 perforation machine.

Using a short instruction manual for the beginners and train them by other machine operators.

Doing some trainees and practical exercises in time intervals of 3 months.

Check the knowledge of each machine operators from time to time.

All trainee programs should includes the advices concerning quality relevant production and their documentation.

21.3 Service support

By and after the PS-1200 machine commissioning the customer is in the position of being fully independent with their own maintenance and technical service.

As other machine suppliers IPM offers the possibility for a continuously service and spare parts.

Furthermore to refresh the trainee course and knowledge status for all machine operators.

Mechanical Specification : Perforation Unit PS-1200

Date : 10/04/2002

1. steel frame of rectangle profiles of 100*80*4 mm with base plates; all three perforation units assembled on a base I-steel frame
2. welded steel construction
3. painted in grey RAL 7032 (Rittal colour), rub-down proof
4. rear side integrated Rittal compact box (for high voltage transformers); tight assembled with the steel frame
5. rear side Rittal compact box : 2 * 800*1200*400 mm, weight approx. 500 Kg
6. dimensions-all-over of each perforation unit without side-channel compressors : see dwg's
7. web speed : max. 250 m/min
8. plug-wrap web width : 1130 mm max. - roller web width : 1200mm
9. web tension : 200 - to 600 N
10. vertical double web path into each perforation unit
11. perforation inner room : perforation dust, out-gassing, Ozone
12. welded top steel plate; two dust exhausting connectors of 100 mm diameter
13. doors, top plate and covering of 2.0 mm steel plates
14. slot across the web (plus 20 mm of total web width) with a open width of 6.0 mm for a easy web in-let and out-let
15. two side doors and one front steel sliding device; each door on left and right hand side of the perforation section; normal cross-way locks
16. doors with a wide opening of more then 90 degree; doors easy removable
17. assembling plates for safety switches flap on bottom insides of locking door sides; safety switches on frame side
18. contact lines around all doors for EMI sealing of 12*6 mm
19. glued and conducted EMI sealing of 12*6 mm inside of all doors
20. inside covering of perforation section with noise reduced and temperature resistance
21. material on glass fibre base
22. light running Aluminium drum rollers in 100-mm and 60-mm diameter; chemical black
23. coated; for a effective web width of 1200 mm
24. web leading, alignment and parallel with a tolerance of +/- 0.1 mm
25. divert drum rollers with a Aluminium or sheet metal profile across the whole web of dust exhausting ; positioned above the perforation section, matched to the web out/inlet, dust exhausting connector of 60 mm diameter on the right hand-side, connection provided for central dust exhaust system
26. air bolster between the in/out-let for the double web path; made of AL or sheet material profile; arranged underneath the perforation section; web gap matched, air-inlet connector of 60 mm diameter on the right hand side, connected to the top positioned side-channel-compressor – one side

- channel compressor; type : Elektror Mueller SD 42, 2.8 m³/ min, 1.3KW, 230/400V/AC, Weight : 21.5 Kg; dimensions : width = 358 mm, high = 357 mm, connection : 45 mm diameter
27. web gap of double web path : 0.5 - 0.6 mm
 28. tooth disk with approx. sensor and holder for standstill detection assembled on the first in-let roller of the first perforation unit
 - 29.perforation section with electrode device, pneumatic electrode gap; opening, SKF-16-G-9 leading bars in lengths of 1160 mm (see point 34)
 - 30.rear side positioned electrode device with a fix position to the web; electrode pin resetting with a additional pressing plate; see points 45 – 50
 - 31.move forward function of the front electrode device for a gap opening of 320 mm
 - 32.quadruple parallel leading devices with pneumatic cylinders, with additional covering
 - 33.parallel tolerances for the electrode gap : 1.5 - 1.6 mm +/- 0.1 mm
 - 34.parallel tolerances of web leading : in the electrode gap centre with +/- 0.1 mm
 - 35.manual gap adjustment : +/- 0.2 mm - see point 31/32
 - 36.four SKF bowl leading bars 16-G9 with halters, surface coated and grinding for a web width of 1160 mm
 - 37.middle distances of leading bars in y-axis: depends of electrode holder dimension
 - 38.Festo system air pressure unit with all accessories, pneumatic functions for electrode device opening and electrode pin resetting; see point 45; positioned underneath and on the right had-side of the perforation section
 - 39.close/open position of electrode device with cylinder integrated switches
 - 40.two light sensor controls for the inner perforation section
 - 41.put-through isolation plates for all high-voltage wires from the rear side transformer box to all 40 rear side positioned electrode pairs
 - 42.electrode air cooling supply via four plastic pipes; each with 60 mm diameter; parallel and on distance to the electrode holders assembled
 - 43.air-cooling supply with transparent PVC tubes to all 40 electrode pairs, 8.0 mm inner diameter
 - 44.air cooling supply of the 60 mm PVC pipes via flexible plastic tubes; right hand-side installed; connected to two side-channel-compressors; placed above the perforation unit four side channel compressors: Elektror Mueller SD-6, 4.6 m³/min, 2.3KW/3*400V/AC, weight=35 Kg; dimensions: width=396 mm, high=435 mm, connection=55 mm
 - 45.air cooling pressure and consumption : min. 55 mbar by around 4 * 200 m³/h
 - 46.air pressure control switches : system air pressure 6 bar
 - 47.half automatic controlled electrode pin setting within a isolation plate in dimension of 1200*250*10 mm, for all pins together of rear side positioned electrode sets with forward pressing of the plate by an opened electrode gap; supported with the opening movement of front device
 - 48.re-setting of all pins of rear side positioned electrode sets with pressing through the closing of the electrode gap by four leading cylinders
 - 49.out pressing of all pins of all front side electrode sets with the same plate; their fixed front position before the front electrode sets; within the backward movement via four leading cylinders
 - 50.re-setting of all pins of all front electrode sets with the same plate into the electrode gap; through the pressing of closing movement of the front electrode sets; close the gap
 - 51.number of electrode pins on each set side: 40*12=480; dimension of ridge free Tungstam WT-20 electrode pins : 1.0 * 80 mm; pressing power for all 480 pins : 300 - 500 N
 - 52.control of pin setting procedure with cylinder integrated limit switches
 - 53.single dimension of each of electrode pairs : 440 * 25 * 33 mm
 - 54.AL-electrode holders; consist of the top fix and bottom variable side; edges rounded, slide able on the SKF-16-G9 bowl leading bars; integrated sliding capsules made of Teflon; fixed by M5 brass screws
 - 55.all three side-channel-compressors (see point 24 and 42) positioned on the top steel frame above the whole perforation unit
 - 56.catwalk for the machine operator; positioned on the perforation front side

General Specification of Perforation System PS-1200

Date : 31/3/2002

- electrostatic surface-all-over and certain area perforation
- Plug-Wrap-Paper weight : 20 - 40 g/sqm
- porosity range : from 500 - 2000 C.U.
- number of single bobbins and perforation channels : 40
- min. Plug-wrap single bobbin web width : 27 mm +/- 0.3 mm
- max. Plug-wrap single bobbin web width : 28 mm +/- 0.3 mm
- max. web width : 40 * 28 mm (+ 10 mm) = 1130 mm
- surface-all-over perforation : 40 * 12 = 480 single perforation lines across the web
- certain area perforation : 5.0 - 24.0 mm +/- 0.3 mm, symmetrically on each bobbin width
- porosity variations <= 500 C.U. ----- +/- 40 C.U.
501 - 1000 C.U. ----- +/- 80 C.U.
1001 - 2000 C.U. ----- +/- 120 C.U.
depends on paper quality and without optical in-line porosity scanning system OPSS
- perforation power with three times double web path and a perforation width of 24 mm on each bobbin ≥ 120.000 C.U.*m/min; 500 C.U. = 240 m/min, 2000 C.U. = 60 m/min
- roll web width : 1200 mm
- maximal web speed : 250 m/min
- electrode gap : 1.6 - 1.7 mm max.
- three perforation units cascaded in web direction and with double web path on all perforation units
- dimension of each perforation unit : approx. width 1600, deep 1.400, high 1800 mm
- each perforation unit in order of pos. 6; equipped with light running rollers, double web path, three doors, two top 100 mm diameter dust exhaust connector, noise reduced material, leading bars for electrodes, front moveable electrode device for easy web in-let, pin setting device, safety switches, high-voltage connection board, terminal box etc.
- two side-channel-compressors for the electrode air cooling; installed and on the top of the perforation base frame
- rear side positioned transformer boxes
- 19"-electronic cabinet; positioned next to the perforation units
- 40 pairs of 12 pin electrodes in each perforation unit
- manual pulse-width control from 8 - 12 μ s for each perforation electrodes with 40 perforation channels in total
- manual common frequency control from 1000 - 6000 Hz for all 40 perforation channels of all three perforation units
- provided space and interfacing for automatic porosity measuring and controlling with OPSS-1 of each perforated bobbin
- hole-size diameters of all operating electrodes can be influenced by variation of pulse-length duration in ranges from 60 - 120 μ m
- hole densities and distances down web can be influenced by variation of spark-repeat frequency, adjustable and synchronised with the web speed or manual between 500 - 6000 Hz to obtain certain hole densities and distances in the web direction and across the web
- machine operation can be carried out with internally fixed spark frequencies or synchronised with the web speed
- perforation remote control for all three electronic cabinets and perforation units from the machine control panel; see unwind and rewind stands

- intervals for electrode pin adjustment : min. after 10 - 12 production hours
- life time of 1.0*80 mm Tungfram ridge free electrode pins : approx. 2.500 operating hours
- electrode air cooling with two side-channel-compressors for each perforation unit : approx. 4 * 200 m³/h by min. of 55 mbar
- side-channel-compressor for the air-bolster of double web path : air amount approx. 80 m³/h by 50 - 80 mbar
- main power consumption of each perforating unit : approx. 22 KVA
- mains : 3*400V/PE/50 Hz/10mm²-PE
- intercircle voltage : 300V/DC/35A max.
- temperature range : 5 – 35 1C
- dust exhaust amount : min. 3 * 1.800 m³/h by min 200 mmWG; supplied by the customer
- spare part package
- CAD-drawings in English and as DXF-files
- manual and spare part list in English

Specifications

Above specifications are indicative and IPM reserves the right to alter or modify such specification if in their opinion and for reasons of technical progress such changes will produce a better piece of equipment.

Electrical Specification and existent units : Perforation system PS-1200

Date : 10/04/2002

- Surface-all-over and certain area perforation
- porosity ranges from 500 up to 2000 C.U.
- web widths up to 1200 mm and speeds from 50 to 250 m/min
- three perforation units cascaded in web direction
- double web path on each perforation unit
- space and interfacing for a provided optical in-line porosity control system OPSS
- all three perforation are units supplied by the customer
- each perforation unit with 40 pairs of 12-pin electrodes - supplied by the customer
- three perforation units positioned between a unwind and rewinding machine
- unwind and rewind stands are supplied by the customer

Pos. 1 : three perforation units are cascaded in web direction

- installed between unwind and rewind stand
- dimension of each approx. : width 1600 mm, depth 1.400 mm, high 1800 mm
- specified with the base drawings and specification from IPM

Pos. 2 : three high-voltage transformer boxes

- Rittal double boxes in total : width = 1600 mm, high = 1200 mm, depth = 400 mm
- rear-side integrated on each perforation unit
- three high-voltage transformer boxes, rear-side of perforation units placed
- each fully completed with 40 plug-in high-voltage transformers HV-700-A
- completed with wiring and high-voltage plug-able electrode cables to the perforation section
- cables connected to the 19" electronic cabinet which next positioned to perforation unit

Pos. 3 : three high-voltage transformer boxes

- rear-side on each perforation units placed
- 19" electronic cabinets for each perforation unit
- dimensions : width = 600 mm, depth = 600 mm, high = 1800 mm
- three fully equipped with 19" electronic cabinets in dimensions of 600*600*1800 mm
- glass front door and internal air fan convection
- each with mains power supply 3*400V/50Hz/PE/approx. 22KVA
- each cabinet with perforation control units
- power supplies of 300V-DC/35A, 230-V-AC/2A, 12V-DC/5A, 24V-DC/2A
- each with 40 pieces of IGBT modular and plug-in perforation power modules IPM-PM-004
- each with perforation control and interface circuit boards IPM-FR-001 and IPM-IF-005
- manual and provided automatic porosity control
- machine and perforation interface
- complete wiring and coax-cable connections to the high-voltage transformer cabinet

Pos. 4 : spare part package

- four plug-in high voltage transformers HV-700-A
- six IGBT power modules IPM-PM-004
- one perforation circuit board IPM-FR-001, one interface circuit board IPM-IF-005
- high voltage spare cables and installation material
- several small spare parts as like plugs, fuses etc.

Pos. 5 : 12-pin electrode pairs and holders

- 120 pairs of 12-pin electrodes = 240 pieces of electrode bodies for each perforation unit
- all completed with 1.0 mm * 80 mm Tungfram pins; ridge free performance
- 240 stainless steel holders and accessories
- air cooling plastic tubes

Pos. 6 : perforation units in order of position 1

- technical performance in order of the specification dated 10/04/2002 by IPM
- quad-pipe steel construction in order of the base IPM dwg's
- each in dimensions of approx. : width 1700 mm, depth 1.400 mm, high 1800 mm
- integrated rear side console for high voltage transformer box
- fully assembled with leading bars for the electrode holders
- front side and pneumatic removable electrode unit
- double web path with all rollers
- three doors with inside noise reduced material
- electrode pin setting unit
- all pneumatic functions
- air pipe distribution and connections for all 40 pairs of 12-pin electrodes
- two side-channel-compressors for electrode air cooling for each perforation unit; placed on a additional steel construction on the top of perforation uni
- one side-channel-compressor for the air-bolster of double web path; placed on the same steel construction on the top of perforation unit
- one dust exhaust device of double web path
- safety and air pressure switches and terminal box

