Important Note:

These Operating Instructions apply to:

Type:	NKH 400
Device No:	203634
Year of Manufacture:	October 2011
Article No:	03940000

Netter GmbH refuses to accept any responsibility for bodily injury or property damage resulting from non-compliance to the notes and instructions contained in these Operating Instructions.

Netter GmbH
www.NetterVibration.com

Germany
Fritz-Ullmann-Straße 9
55252 Mainz-Kastel
Tel. +49 6134 2901-0
Fax +49 6134 2901-33
info@NetterVibration.com

United Kingdom
92A Littleworth Road
Hednesford Cannock
WS12 1PA
Tel. +44 1543 424990
Fax +44 1543 423196
info-uk@NetterVibration.com

Switzerland
Erlenweg 4
4310 Rheinfelden
Tel. +41 61 8316200
Fax +41 61 8311291
info-ch@NetterVibration.com

Compacting dry ramming material in crucible melting furnaces

using Netter NKH vibrating crosses

NKH vibrating crosses are clamped by means of hydraulic cylinders and foot operated pumps.

1. Description and theory of the process

The compacting device consists of a cross-shaped clamping fixture with hydraulic cylinder, a hand-operated pump, a connecting hose, a pump/cylinder and a type NVRT 105 turbo vibrator (see leaflet no. 14). The vibrator is clamped to the base of the device using a non-positive quick-clamp mechanism. Actuating the hand-operated pump, the base of the device is pressed against the upper part by means of a hydraulic cylinder pressing 4 jaws against the wall of the ramming template. Thus a non-positive connection between template and vibrator is generated. The vibrations are transferred to the ramming material causing the de-aeration and thus the desired compacting of the material. After the cylinder has been released, the jaws are drawn back in.

Thus, the material is not compacted by local tapping but due to the vibrations of the entire template, i.e. the entire ramming material. Without load, NVTR 105 pneumatic turbo vibrators achieve a frequency of min. 13,000 UpM (at 6 bar, connected to a hose).

Actually, the vibrator does not reach its idle speed but operates synchronously with natural resonance or with the harmonic next below idle speed (= a multiple of natural resonance). With these resonance vibrations, the entire template has even vibrations. Otherwise, this would not be resonance. Moreover, the amplitude of vibration in a state of resonance is much higher. This results in higher acceleration and thus in better compacting.

The frequency at the ramming template is between 7,200 and 8,500 UpM, depending on the stiffness of the template. Centrifugal force depends on the torque of the vibrator and on the square of the achieved speed. Thus, higher frequencies result in better compacting. The stiffer the template (due to wall thickness and/or stiffening rings), the higher the frequency.

Therefore, the compacting quality very much depends on the use of a template with adequate wall thickness or ring-shaped welded stiffening rings. For templates with an inner width of 600mm, we recommend a wall thickness of 6-8mm, for larger templates, a wall thickness of 8-10mm is recommended. Otherwise, ring-shaped stiffening rings must be inserted (round material d = 10mm, see figure 4).

Similar vibrators are used for bottom compaction. For this purpose, however, a tapping effect must be generated. Therefore, the heavy bottom plate is moved in natural

resonance by means of vibrators. This effect is achieved by reducing air supply (see description below). Generally, the torque (unbalance) of the NVTR 105 is sufficient for bottom compaction.

2. Safety

Noise level: During the compaction of the melting pot, the noise level of 85 dB(A) is exceeded excessively. Therefore, appropriate protective measures must be taken.

Use ear protection or ear plugs! During bottom compaction, the noise level about 85 dB(A).

Infeed: The operating instructions must be observed. It is absolutely necessary to ensure the secure fix of the template.
If non-cylindrical templates are used, the pinch sticks of the vibrating cross must be adjusted to the incline of the wall.
Check during operation that the vibrating cross does not become loose due to the incline of the template wall.
A minimum pressure of 6 bar and air supply through a 3/4" hose must be ensured.
Avoid patching up the supply hose (cross-section restriction!). Compaction must be checked, see pos. 5.

Template: The ramming template must have walls with sufficient wall thickness, or it must be provided with stiffening rings. Templates with inadequate wall thickness result in insufficient compaction.

3. Preparation

Turbo vibrators have a position in which they cannot start (exhaust pipe hole at 2 pm in assembly position, see figure 1). The reason for the position of the flanges for the use with the vibrating cross is to ensure a safe starting position (approx. 10 am, see figure 1). The exhaust pipe holes are located at the left side above the hose. At the bottom plate, the corresponding position of the exhaust pipe holes is at approx. 4 pm.

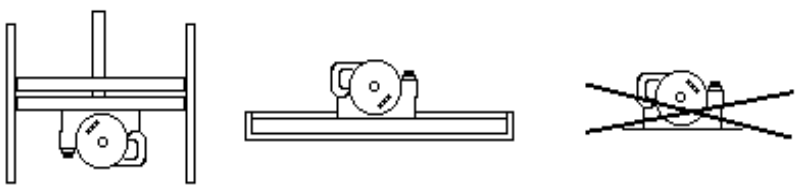


Figure 1

Hard wood profiles (e.g. beech wood) are used to adjust the vibrating cross to different furnace sizes. The jaws can be expanded on each side by max. 15mm, thus bridging a total of max. 30mm. The wood profiles also ensure that the cross does not slip due to vibrations.

The upper part of the profile is secured by screws, or in case of welded stiffening rings by a groove (figure to the right).

The thickness of wood profiles for NKH 300 - 800 crosses must be 64mm to ensure that the guiding grooves (U 60) can slide on the profiles. Width "W" (figure 2) can be calculated from the difference of the cross and the internal diameter of the template. W can be calculated as follows (incl. a tolerance of 13mm):

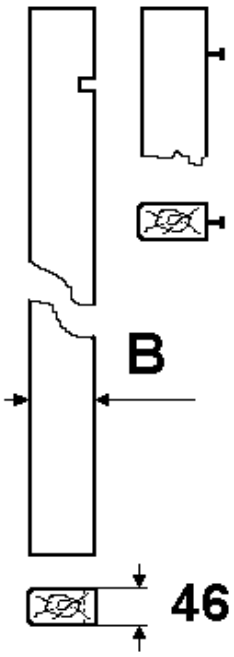


Figure 2

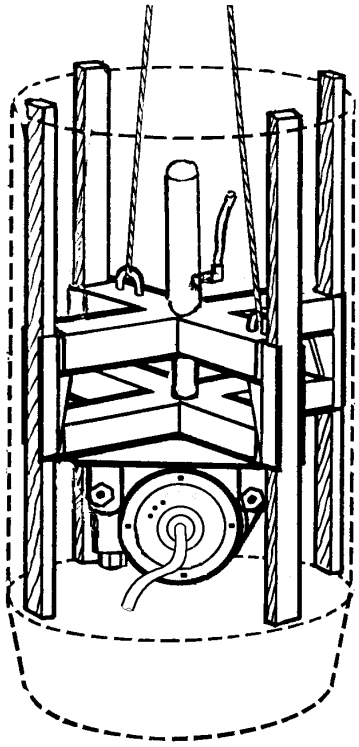


Figure 3

Width $W = \frac{\text{Inner width of template - (nominal size in mm + 25mm)}}{2}$

The nominal size is apparent from the type designation.

Example: NKH 500 in a template with an inner width of 700mm

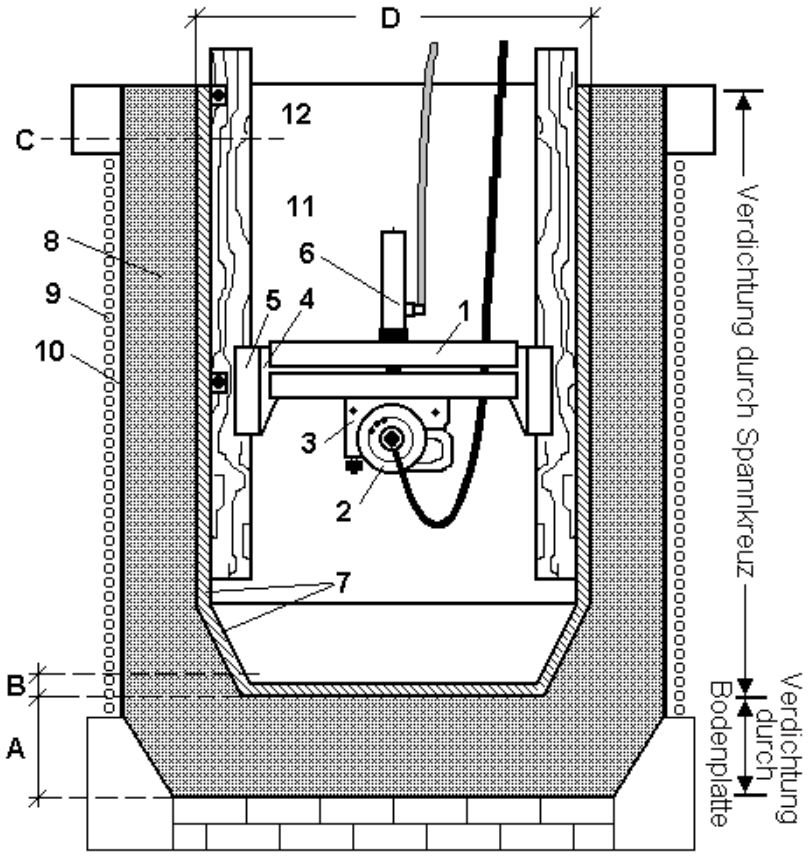
W = (700 - 525)/2 = 88mm

In this case, the profiles have a cross-section of 46x88mm. The length almost corresponds to the cylindrical length of the template (up to 20-50mm above the welding seam to the cone, see figure 3). The profiles must protrude by 100-200mm at the top so that it is possible to suspend them from screws or (if stiffening rings are applied) from recessed areas in the profiles (see sketch on figure 2, above left). Round off the edges for the guide rails with a radius of R = 6mm.

Bottom plates can be ordered at our company (indicate the outer diameter of the melting pot or send sectional drawing of the furnace), or you can manufacture them yourselves according to figure 5. An additional NVH 4 bracket (as in the cross) is required. It must be welded to the stiffening. Up to a melting pot diameter of 1,300mm, the same bracket is used for vibrator and cross.

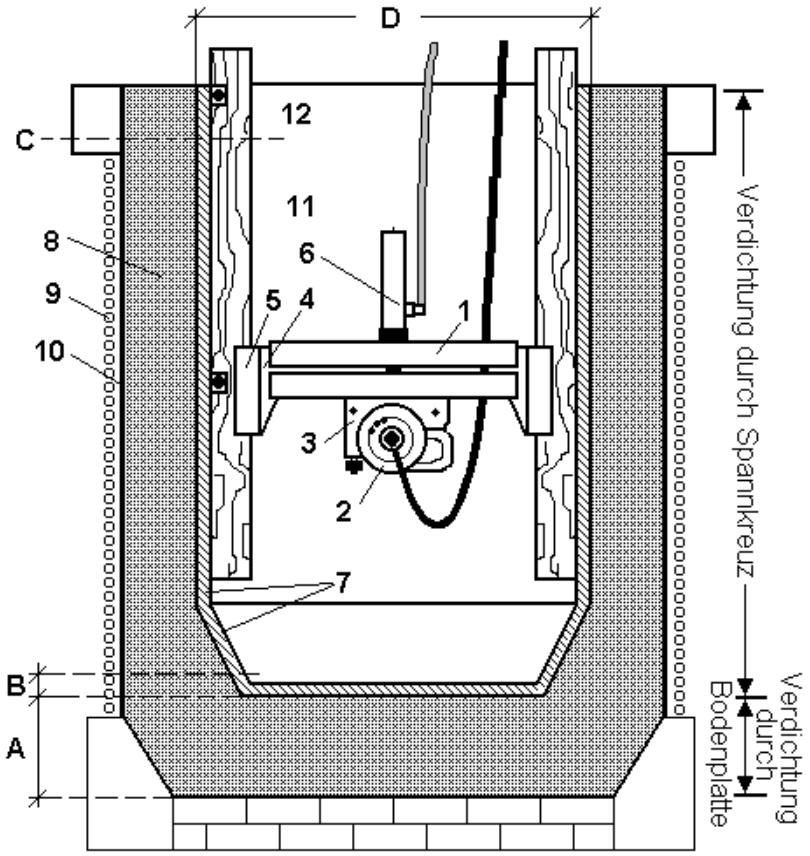
4. Infeed

Upon completion of the general preparation work such as furnace coating with insulation plates etc., the bottom of the furnace is filled with all the ramming material necessary for the bottom. The filling level (A+B) must be at least 15% (B) above the desired end level (A) (see figure 4).



1. Vibrating cross
2. NVTR 105 turbo vibrator
3. NVH 4 bracket
4. Jaws
5. Jaw attachments
6. Hydraulic cylinder
7. Template
8. Ramming material
9. Coil
10. Insulation
11. Hard wood profiles
12. Stiffening

Figure 4



13. Vibrating cross
14. NVTR 105 turbo vibrator
15. NVH 4 bracket
16. Jaws
17. Jaw attachments
18. Hydraulic cylinder
19. Template
20. Ramming material
21. Coil
22. Insulation
23. Hard wood profiles
24. Stiffening

Figure 4

Now the bottom plate with turbo vibrator clamped onto is fitted (see figure 5).

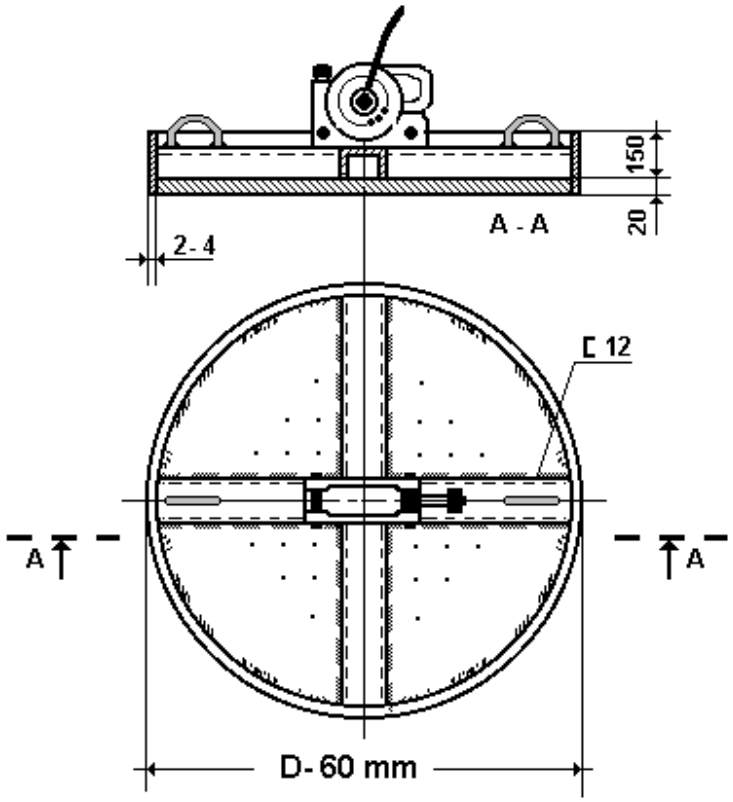


Figure 5

The bottom plate is made of a plate with a thickness of 29mm and an outer diameter which is 60mm smaller than the inner width of the ramming material, i.e. D - 60mm (for melting point diameter "D" see figure 4). The NVH 4 quick clamp mechanism is welded onto the centre of the end-to-end profile on the cross-shaped stiffening made of U 120. Only weld at the longer edges, never transversely to the end-to-end profile. An attached tin edge (d = 2-4mm) prevents material from flowing onto the plate during compacting. Six 4-5mm boreholes in each quarter are used for the de-aeration during vibration and allow for easy removal afterwards.

The bottom plate is made according to the description in the top right corner (figure 5). To this end, a loose NVH 4 bracket is required which must be welded onto the reinforcement profile.

The vibrator is started with full pressure and the sudden opening of the hand-operated valve. Immediately after the vibrator has started, it is reduced to a lower speed. The result is a noticeable tapping effect. The vibration time for the bottom is at least 6-8 minutes. Check whether the bottom has been compacted at least to such an extent as with manual infeed as was the case before. If the material is compacted so much that additional material must be filled in, the surface must be roughened, before vibrating it for another 8 minutes. If the plate moves very much to one side, it must be reversed after half the vibration time. After having removed the bottom plate, you can trowel it off at the desired height and check it with a spirit level. Carefully remove the bottom plate to avoid a vacuum below the plate which could rip bottom layers. This could cause mineralisation. Apply de-aeration boreholes (see figure 5) and/or lift the plate at one side to prevent such mineralisation.

Now the template is inserted and secured against getting out of place by means of wedges.

The template may have an insert made of steel or cast iron. The bottom part, however, must not be completely made of steel because it must be possible for the walls to freely vibrate in the conical area as well (otherwise, this area must be manually

compacted). - The vibrator is removed from the bottom plate and screwed to the vibrating cross.

The vibrating cross is inserted into the template and clamped by rotating the spindle (this can also be done before inserting the template). The ideal position of the vibrating cross is in the lower third up to the centre of the template. Operate the vibrator at very low speed for the first clamping of the vibrator (in order to avoid canting during the first clamping process).

Now the surface around the template must be roughened, the ramming material filled in up to a level of approx. 20cm and slightly compacted by hand. This ensures a good mixing with the separation plane and a nonslip position of the ramming template.

Then, material is filled to the maximum. The unavoidable de-mixing due to the rolling motion of rough grain must be reversed by slightly tapping the material with the hand while material is filled in. (Rough grain always rolls to lower zones, e.g. to the ramming template; see figure 6 to the right). After having filled in the material, it is initially vibrated with full pressure for only 20 to 30 seconds. During this time (i.e. during vibration),the vibrating cross is re-tensioned. The ramming material is reduced approx. to pos. C (see figure 4). The attachment which secures the template against slipping remains in position.

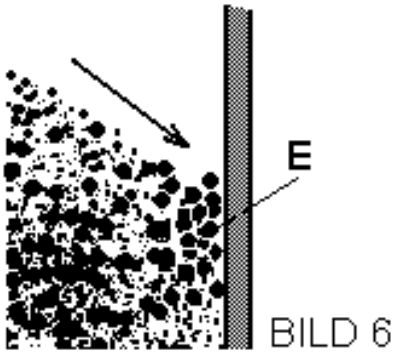


BILD 6

Make sure that the suspension (rope or chain) is not under tension. Otherwise, the template might get shifted out of position.

Now, further material is filled in and vibrated for approx. 30 seconds. After some more material has been filled in, the vibration time is approx. 5-8 minutes; for alkaline and neutral materials, vibration times are shorter. Vibration time depends on material quality, furnace size and template design. In general, the material is vibrated until it does not sag anymore - plus additional 2 minutes to make sure that compaction quality is good.

Before filling in a new layer of material, it is essential to switch off the vibrator and to roughen the surface. Only at the end of the process, during the longer vibration time of 5-8 minutes, material can be filled in without switching off the vibrator. Before filling in the last layer, the attachment of the template can be released.

The vibration times mentioned above refer to acid ramming materials. If alkaline or neutral ramming materials are used, vibration time might be shorter.

5. Checking compaction

In particular, when using the vibrating cross for the first time, we recommend checking the actual compaction on the basis of the filled in quantity of ramming material. A further, however subjective, method is to check the surface hardness of the ramming material with a hand rammer. During vibration, the material only de-mixes on the surface - rough grain rolls into recesses.

6. Removing the vibrating cross after compaction

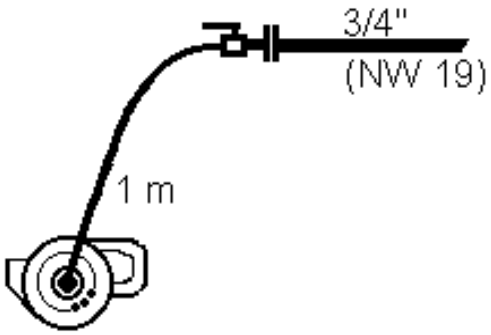
Start the vibrator with a sudden pressure surge and then reduce speed by means of the ball valve such that the vibrator is shortly before stopping. Loosen the bleeder screw at the hand-operated pump to release pressure from the cylinder. Now the vibrating cross loosens and can be easily removed. Never try to remove the vibrating cross as long as it is firmly held in place.

A pressure surge on the vibrator will loosen the vibrating cross if the hydraulic pressure has been released before. Suspend the cross at the crane beforehand.

6. Maintenance

After infeed is completed, the union nut is loosened and the vibrator is removed from the vibrating cross. Put the vibrator onto a soft surface with the hose pointing upwards. Open the control valve and fill approx. 1 - 2 cm^3 type "R" AIR-MOTOR-OIL, or low-viscosity oil (SAE 5-10), or a mixture of one portion of oil and three portions of petroleum into the supply hose. Close the control valve and connect compressed air supply. Then open the control valve. The vibrator now fills with oil. After approx. 15 seconds, the excess oil is discharged, and full speed is reached. Now the device is ready for the next operation and can be stored.

We recommend carrying out this procedure also before the first use of the device, however with an operation time of approx. 3 minutes.



After having cleaned the device according to the above description, you can also check speed. To this end, the device must be suspended on the hose and started. Now, speed can be measured with a sirometer (mechanical vibration meter, available at Netter). If idle speed is below 12,000 UpM, you must check adequate air pressure, the nominal width of the supply hose (3/4" hose required to the coupling),or whether speed is reduced due to air passages in the hose which are not wide enough. Filler pipes for mending (should be avoided!), if any, as well as hose grommets must have a nominal width of at least 12mm.

If the idle speed of the vibrator is below 10,000 vibrations/min, the lamella might be worn out. If you are in doubt, please return the device for testing.

The coupling is equipped with a sieve which must be cleaned if contaminated. To this end, you must first remove the rubber washer and then the sieve.

7. Avoiding malfunction

Observe the following points to avoid malfunction and achieve optimal compaction:

1. Use a ramming template with adequate thickness or stiffness (in case of doubt, send in a drawing).
2. Firmly clamp the vibrating cross; re-tension after first vibration.
3. If a jaw is not firmly applied due to an irregular template (wood heats up at this point), you must insert a metal strip between wood and vibrating cross.
4. Before removing the vibrating cross, it is absolutely vital to loosen it; minor vibrations during removal and also during installation prevent canting. The lowest adjustable speed is enough to this end.
5. Maintenance of the vibrator according to the instructions (do not use oil with high viscosity; check air supply). Required air pressure: at least 6 bar; 3/4“

   hose for the supply line to the ball valve at the vibrator.
6. Make sure that the bottom plate does not rest flat on the edge; therefore, the floor must be levelled out beforehand. The bottom must be aligned horizontally; otherwise the template will have an inclined position (check with the spirit level).
7. Observe the correct frequency (tapping frequency) during bottom compaction.
8. Check compaction according to the description above (compare filling quantity, check with rammer).
9. Check the position of the template before and after compaction, also at the lower part, e.g. inside by means of a plumb line.
10. Observe the instruction manual.