

減低工業噪音的實用指南

A Practical Guide to Industrial Noise Reduction



勞工處職業安全及健康部
Occupational Safety and Health Branch
Labour Department



職業安全健康局
OCCUPATIONAL SAFETY AND HEALTH COUNCIL

本指南可在勞工處職業安全及健康部各辦事處免費索取，亦可於勞工處網站 <http://www.labour.gov.hk/public/os/D/Noisered.pdf> 直接下載。有關各辦事處的地址及查詢電話，請致電2559 2297。

歡迎複印本指南，但作廣告、批核或商業用途除外。如需複印，請註明錄自勞工處刊物《減低工業噪音的實用指南》。

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目 錄

一. 引言	4
二. 一般的工業噪音問題及解決方法	
1. 抽氣扇噪音	6
2. 通風喉噪音	6
3. 喉管噪音	6
4. 機器噪音	8
三. 一般嘈吵機器的噪音控制措施	10
四. 資料查詢	12
附圖	14

CONTENTS

I . INTRODUCTION	5
II . COMMON INDUSTRIAL NOISE PROBLEMS AND SOLUTION	
1. <i>FAN NOISE</i>	7
2. <i>DUCT NOISE</i>	7
3. <i>PIPE NOISE</i>	7
4. <i>MACHINERY NOISE</i>	9
III . NOISE CONTROL MEASURES FOR COMMON NOISY MACHINES	11
IV . USEFUL INFORMATION	13
FIGURES	14

引言

如僱員處身於工廠及工業經營（工作噪音）規例規定的初級或頂級措施聲級或超越該等聲級，東主除提供認可的聽覺保護器外，還須盡可能利用其他方法來減低噪音暴露量。為達到這一目標，東主需要實行噪音控制措施計劃，這些措施包括考慮到噪音控制技術的發展而定期檢討進一步減低噪音的可行性。

限制噪音暴露量的最可靠方法，是減低噪音聲級。以下各章列述一般工業噪音來源的簡單問題及其可行的解決方法。至於複雜的問題，讀者可諮詢獨立的噪音控制專家或職業安全健康局。

INTRODUCTION

Where employees are exposed at or above the first or peak action levels of the Factories and Industrial Undertakings (Noise at Work) Regulation, the proprietor is required to reduce the noise exposure as far as is practicable by means other than provision of approved ear protectors. To achieve this, the proprietor will need to implement a programme of noise control measures which should include regular reviews of the feasibility of further noise reduction, taking account of development in noise control techniques.

The most reliable way of limiting exposure is to reduce the noise level itself. The following sections deal with simple problems of common industrial noise sources and their possible solutions. For complicated problems, readers are advised to consult independent noise control specialist or the Occupational Safety and Health Council.

二. 一般工業噪音問題及解決方法

1. 抽氣扇發出的噪音

問題成因	解決方法
(a) 氣流湍動的噪音 由於氣流遇上阻礙令空氣湍動，因而造成噪音（圖1）	— 避免流動組件產生任何突變 — 避免將抽氣扇放置在障礙物、彎位及變型部份的後面（圖2） — 所有開敞式抽氣扇加設錐形或闊鐘口形蓋（圖2） — 將抽氣扇放在內襯有吸音物料的箱內（圖3） — 安裝減聲器（圖3）
(b) 嗶聲噪音 由於抽氣扇高速運行所產生的噪音	— 減低抽氣扇速度 — 另選轉速較低的抽氣扇
(c) 高頻率軸承噪音 因軸承損壞而產生噪音	— 更換損壞了的軸承

2. 通風喉發出的噪音

問題成因	解決方法
(a) 發出軋軋聲噪音的通風喉 由於通風喉表面受氣流感應而引致震動（圖4）	— 以承托碟加強被震動的嵌板的硬度 — 在震動的嵌板使用具「阻尼」(減震) 材料（圖5）
(b) 溢出的低頻噪音 由於通風喉內的噪音經過通風喉表面（圖4）	— 在通風喉表面加上隔音材料（圖6）

3. 喉管發出的噪音

問題成因	解決方法
(a) 如鐘鳴的喉管噪音 因液體在喉管內流動而刺激管壁所引致的震動（圖7）	— 在喉管表面加上隔音材料（圖8）
(b) 震動的喉管發出的噪音 喉管的震動傳送到建築物其他部份（圖7）	— 用下述物品／方法隔開震動 (a) 彈性聯軸節（圖9） (b) 在喉管及其承托物之間加設防震器（圖10）

II . COMMON INDUSTRIAL NOISE PROBLEMS AND SOLUTIONS

1. Fan Noise

Causes of Problem	Solutions
(a) Turbulent air flow noise Generated by turbulence of air due to obstacle in air flow (Fig. 1)	<ul style="list-style-type: none"> – avoid creating any sudden change in flow components – avoid locating fans immediately behind obstacle, bends, transformation sections (Fig. 2) – fit coned or bell mouth cover to open running fans (Fig. 2) – enclose fan in a chamber internally lined with sound absorbing material (Fig. 3) – install silencers (Fig. 3)
(b) Whining noise Generated by high fan running speed	<ul style="list-style-type: none"> – reduce fan speed – re-select fans of lower rotating speed
(c) High frequency bearing noise Generated by worn-out bearing	<ul style="list-style-type: none"> – replace worn-out bearing

2. Duct Noise

Causes of Problem	Solutions
(a) Rumbling duct panel noise Caused by duct surface being induced to vibrate by air flow (Fig. 4)	<ul style="list-style-type: none"> – stiffen vibrating panel with supporting webs – apply damping material to the vibrating panel (Fig. 5)
(b) Low frequency breakout noise Caused by noise inside duct passing through duct surface (Fig. 4)	<ul style="list-style-type: none"> – apply lagging to duct surface (Fig. 6)

3. Pipe Noise

Causes of Problem	Solutions
(a) Ringing pipe noise Caused by pipe wall being set into vibration by fluid flow inside the pipe (Fig. 7)	<ul style="list-style-type: none"> – apply lagging to pipe surface (Fig. 8)
(b) Vibrating pipe noise Generated by vibration of piping being transmitted to other parts of the building (Fig. 7)	<ul style="list-style-type: none"> – isolate the vibration with <ul style="list-style-type: none"> (a) flexible coupling (Fig. 9) (b) anti-vibration isolator between pipe and its supports (Fig. 10)

4. 機器發出的噪音

問題成因	解決方法
<p>(a) 撞擊噪音 因撞擊如收集物料的漏斗的硬物表面所產生的噪音</p>	<ul style="list-style-type: none"> - 用橡膠或軟墊等軟物作為墊子 (圖11) - 減少物料下跌的高度 (圖11)
<p>(b) 由震動的嵌板／皮帶發出的嘎嘎聲 因面積大的嵌板受刺激而放射聲能，例如五金啤機飛輪蓋或寬傳動帶</p>	<ul style="list-style-type: none"> - 使用窄帶減低傳動帶的震動表面的面積 (圖12) - 以線網蓋代替飛輪蓋 (圖13) - 用承托蹠加強被震動的嵌板的硬度 - 在震動的嵌板使用具「阻尼」(減震) 的材料
<p>(c) 水泵發出的嗚聲噪音 因水泵震動引致發出噪音</p>	<ul style="list-style-type: none"> - 加上泵外罩 (圖14) - 在水泵及地面之間加設防震器
<p>(d) 由結構傳遞而發出的噪音 因機器的震動傳遞至建築物的其他部份</p>	<ul style="list-style-type: none"> - 在機器的底部及地基之間加設防震器 (圖15) - 為僱員提供隔離室 (圖15) - 在堅實的地面安裝機器
<p>(e) 排氣口發出的噪音 因從排氣口放出加壓氣體引致發出噪音</p>	<ul style="list-style-type: none"> - 安裝合適的隔音罩
<p>(f) 嘈吵的機器 由數個嘈雜部份導致產生噪音</p>	<ul style="list-style-type: none"> - 提供噪音隔離室，以便僱員在非實際操作嘈吵的機器時可進入該室 (圖16) - 用隔音罩盡量將機器圍封 (圖17) - 在面對嘈吵機器的牆壁和天花加上吸音的物料，以減低反射的聲音 (圖18) - 在嘈吵的機器和其他僱員之間放置隔音屏障/ 隔聲板以阻擋部份噪音 (圖19) - 適當保養機器 - 只在實際使用時才開動嘈吵的裝置 - 增加嘈吵的機器與僱員之間的距離

4. Machinery Noise

Causes of Problem	Solutions
<p>(a) Impact noise Generated by impact on hard surface such as the side of a collection hopper</p>	<ul style="list-style-type: none"> – cushion with soft material such as rubber or resilient pads (Fig.11) – reduce the material fall height (Fig.11)
<p>(b) Rattling noise from vibrating panels/belts Caused by large panel radiating sound energy when excited, such as flywheel cover of power press or broad driving belt</p>	<ul style="list-style-type: none"> – reduce the size of the vibrating surface of broad driving belt by narrow belts (Fig.12) – replace flywheel cover by wire mesh cover (Fig.13) – stiffen the vibrating panel with supporting webs – apply damping material to the vibrating panel
<p>(c) Whining pump noise Caused by vibration of the pump</p>	<ul style="list-style-type: none"> – enclose the pump (Fig.14) – install anti-vibration isolator between the pump base and the floor
<p>(d) Structure borne noise Caused by vibration of machine being transmitted to other parts of the building</p>	<ul style="list-style-type: none"> – install anti-vibration isolator between the machine base and the foundation (Fig.15) – provide isolated room for employees (Fig.15) – install machine on heavy floor
<p>(e) Exhaust air noise Generated by release of pressurised gases from exhaust</p>	<ul style="list-style-type: none"> – install suitable muffler
<p>(f) Noisy machinery Noise caused by several noisy parts</p>	<ul style="list-style-type: none"> – provide noise refuges which employees can enter when not actually operating noisy machine (Fig.16) – use acoustic enclosure to cover the machine as fully as possible (Fig.17) – line sound absorbing material on the wall and ceiling facing the noisy machine to reduce reflected sound (Fig.18) – place sound barrier/screen between the noisy machine and other employees to block part of the noise (Fig.19) – maintain machine properly – switch on noisy devices only when actually in use – increase the distance between noisy machine and employees

三. 一般嘈吵機器的噪音控制措施

嘈吵的機器	控制措施
(a) 塑膠碎料機 (圖20)	— 全套隔音罩
(b) 五金啤機 (圖21)	<ul style="list-style-type: none"> — 隔音罩互鎖以形成啤機護罩，從而阻擋公模發出的衝擊聲音 — 在啤機下裝上隔震器 — 在氣動排氣口裝配減聲器 — 將具「阻尼」(減震) 材料施用於飛輪蓋上 — 收集箱襯上柔軟材料以消滅物料跌墜噪音
(c) 織布機	— 在機器下裝置隔震器
(d) 精紡機	<ul style="list-style-type: none"> — 在氣動收集系統裝配減聲器 — 使用良好配件及平衡緯管 — 在鋼環挾紗器和介輪裝配隔離器
(e) 圓鋸	<ul style="list-style-type: none"> — 銳利刀口 — 正確刀口圓周速度 — 將具「阻尼」(減震) 材料施用於刀口上
(f) 手提氣動混凝土破碎機 (圖22)	<ul style="list-style-type: none"> — 使用合適的隔音罩以消滅排氣噪音及從機身發出的噪音 — 鋼鑽頭使用具「阻尼」(減震) 材料以消滅如鐘鳴的噪音
(g) 空氣壓縮機 (圖23)	— 密封外罩
(h) 撞擊式打樁機	<ul style="list-style-type: none"> — 裝上具有彈性的配件，放置在樁柱頂部以緩衝樁錘的撞擊 — 遮蓋樁柱及打樁機 — 減低鋼樁的震動

III. NOISE CONTROL MEASURES FOR COMMON NOISY MACHINES

Noisy machines	Control measures
(a) Plastic granulator (Fig. 20)	– complete acoustic enclosure
(b) Power Press (Fig. 21)	<ul style="list-style-type: none"> – acoustic enclosure interlocked to form press guard to block impact sound from the tool-and-die – vibration isolators under press – silencer fitted to pneumatic exhaust – damping material supplied to the flywheel cover – collection bin lined with soft material to reduce material dropping noise
(c) Weaving machine	– vibration isolators under machine
(d) Spinning frame	<ul style="list-style-type: none"> – fitting of silencer to pneumatic collection system – use of well fitting and balanced bobbins – fitting of isolators to ring holders and carrier
(e) Circular saw	<ul style="list-style-type: none"> – sharp blade – correct blade peripheral speed – application of damping material to blade
(f) Portable pneumatic concrete breaker (Fig. 22)	<ul style="list-style-type: none"> – suitable muffler to reduce exhaust and body radiated noise – damping material to steel bit to reduce ringing noise
(g) Air compressor (Fig. 23)	– well sealed enclosure
(h) Percussive piling machine	<ul style="list-style-type: none"> – resilient packing over top of pile to cushion the blow of the hammer – enclosure for pile and pile driver – damping of steel pile

四. 資料查詢

如你對本指南有任何疑問，或想查詢其他職業安全及健康事宜，你可與職業安全及健康部聯絡：

電話 ： 2559 2297 (辦公時間外，將會自動錄音)

傳真 ： 2915 1410

電子郵件： enquiry@labour.gov.hk

你亦可以透過互聯網絡，找到勞工處提供的各項服務，及主要勞工法例的資料。本處的網址是 <http://www.labour.gov.hk>。

你並可透過職安熱線2739 9000，找到職業安全健康局提供各項服務的資料。

IV. USEFUL INFORMATION

If you wish to enquire about this guidebook or require advice on occupational safety and health, you can contact the Occupational Safety and Health Branch through:

Telephone : 2559 2297 (auto-recording after office hours)

Fax : 2915 1410

E-mail : enquiry@labour.gov.hk

Information on the services offered by the Labour Department and on major labour legislation can also be found by visiting our Home Page on the Internet. Address of our Home Page is [http:// www.labour.gov.hk](http://www.labour.gov.hk).

Information on the services offered by the Occupational Safety & Health Council can be obtained through hotline 2739 9000.

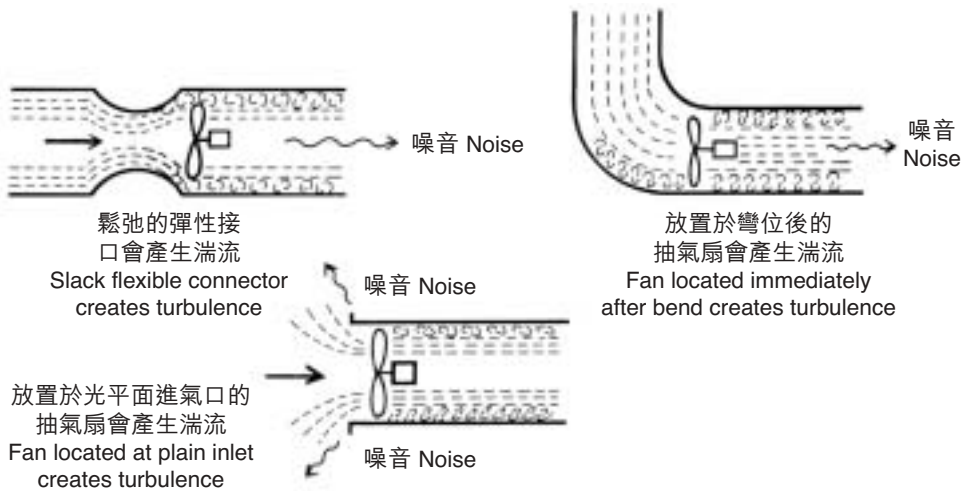


圖1 抽氣扇產生的湍流噪音
Figure 1 Fan turbulent air flow noise

解決方法
SOLUTION

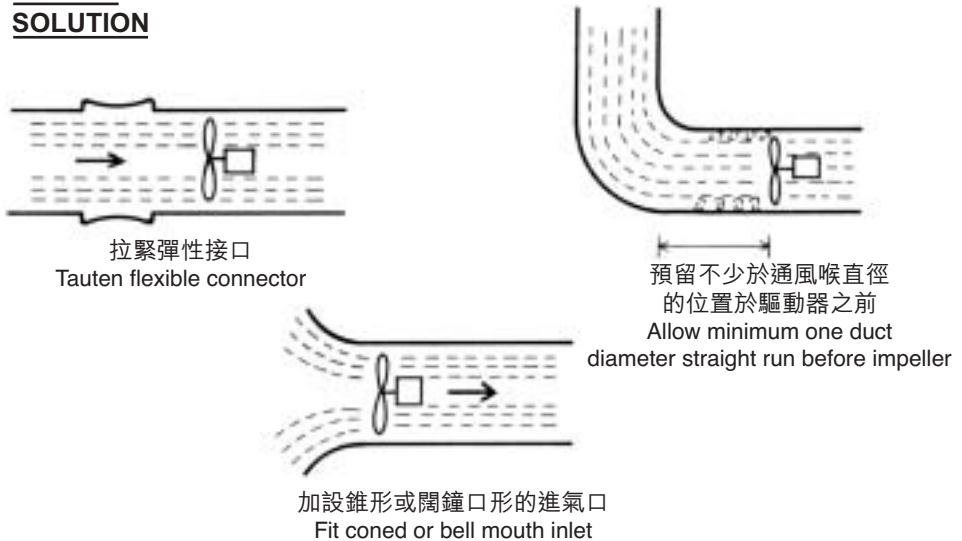
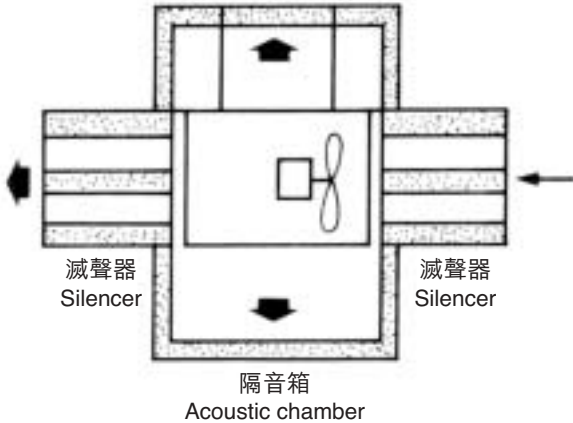


圖2 消滅湍流
Figure 2 Reduction of turbulence

解決方法
SOLUTION



隔音箱

- 用不少於1毫米厚的鉛水鐵皮做箱
- 用不少於50毫米厚帶有孔的保護面的玻璃纖維作為箱的吸音襯墊

Acoustic chamber

- use minimum 1 mm thick G.I. sheet for chamber
- use minimum 50mm thick fibre glass with porous protective facing as sound absorbing lining of the chamber

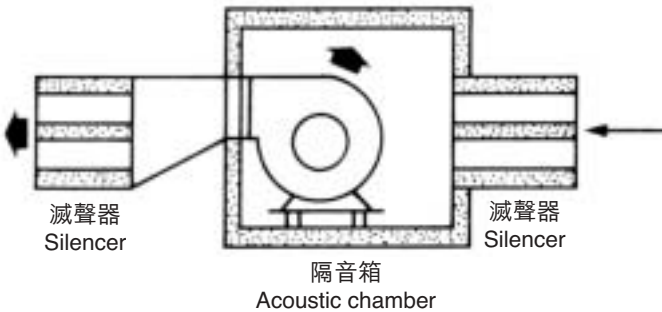


圖3 抽氣扇隔音箱及滅聲器的應用
Figure 3 Application of acoustic chamber and silencer for fans

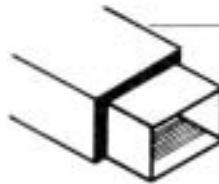
通風喉表面溢出的低頻噪音
Low frequency breakout noise



通風喉嵌板發出
輻輳聲的噪音
Rumbling
duct panel noise

圖4 通風喉發出的噪音
Figure 4 Duct noise

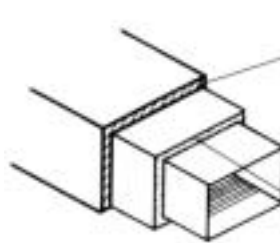
解決方法
SOLUTION



具「阻尼」(減震)的材料
• 用瀝青或橡膠類的材料
Damping material
• use bituman or rubber type material

圖5 使用具「阻尼」(減震)的合成物以消滅由震動的通風喉所發出的噪音
Figure 5 Application of damping compound to reduce noise from vibrating ductwork

解決方法
SOLUTION



外層覆蓋物
• 用不少於13毫米厚的塗灰泥或有基墊的乙烯纖維
Outside cladding
• use minimum 13mm thick plastering or loaded vinyl fabric
吸音材料
• 用不少於50毫米厚的玻璃纖維板
Sound absorbing material
• use minimum 50mm thick fibre glass board

圖6 使用合成的隔音材料以消滅由通風喉所溢出的噪音
Figure 6 Application of composite lagging to reduce noise breakout from ductwork

結構震動而產生的噪音
Structure-borne noise



圖7 喉管發出的噪音
Figure 7 Pipe noise

解決方法
SOLUTION

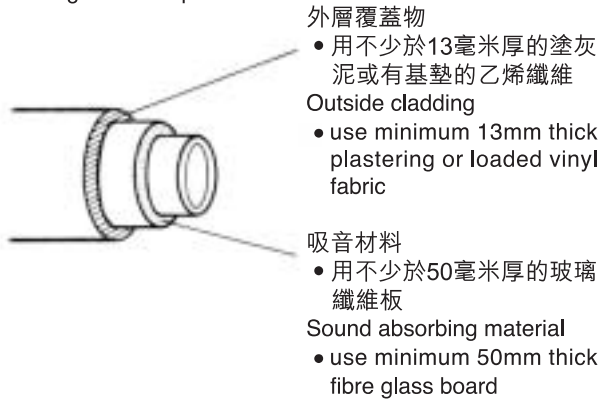


圖8 使用合成的隔音材料以消滅由喉管發出如鐘鳴的噪音
Figure 8 Application of composite lagging to reduce noise from ringing pipe

解決方法
SOLUTION

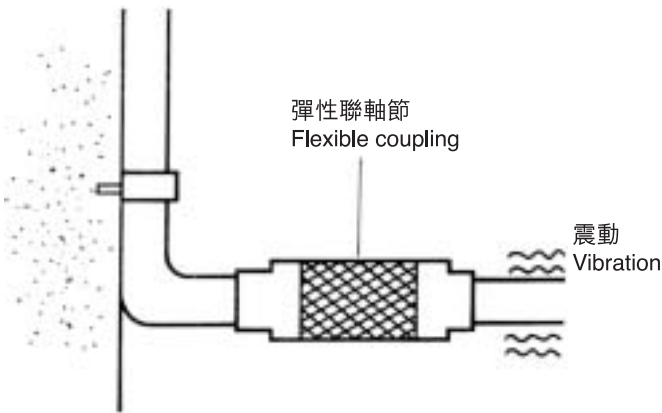
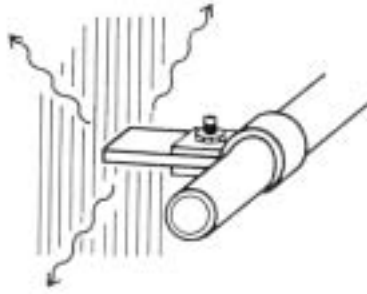
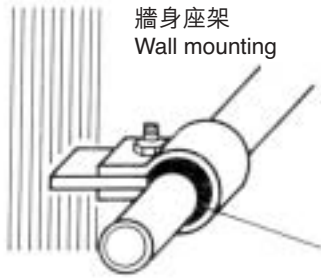


圖9 在喉管加上彈性聯軸節
Figure 9 Flexible coupling for pipes



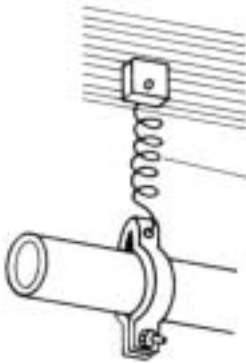
實心固定裝置
Solid fixing

解決方法
SOLUTION



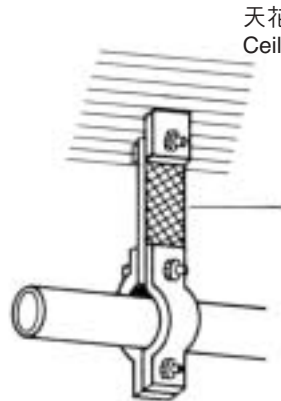
牆身座架
Wall mounting

橡膠隔離器
Rubber isolator



天花吊架
Ceiling mounting

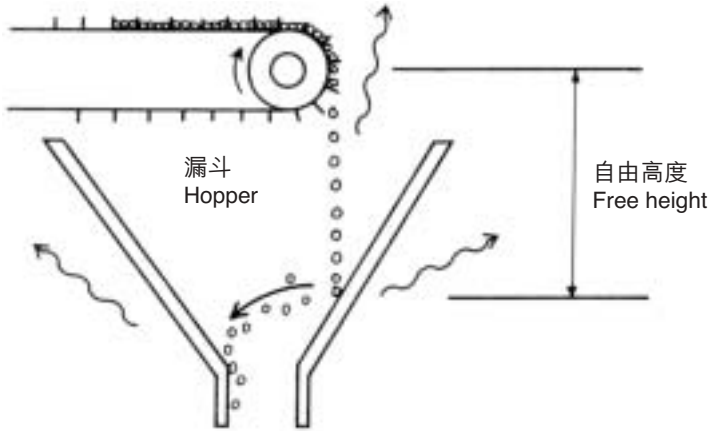
彈簧隔離器
Spring isolator



天花吊架
Ceiling mounting

橡膠條
隔離器
Rubber
strip
isolator

圖10 防震器
Figure 10 Anti-vibration mounts



解決方法
SOLUTION

輸送器表面覆蓋厚防磨損物料
Conveyor surfaces covered with thick abrasion resistant material

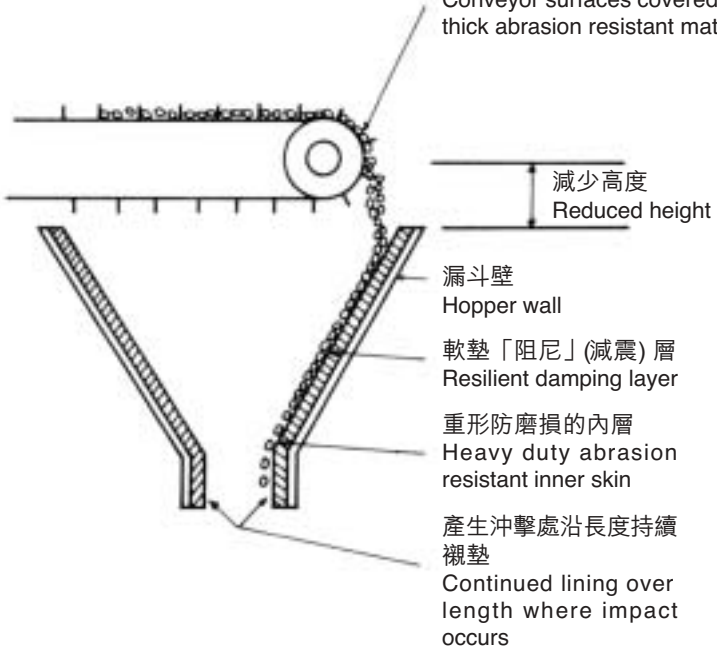
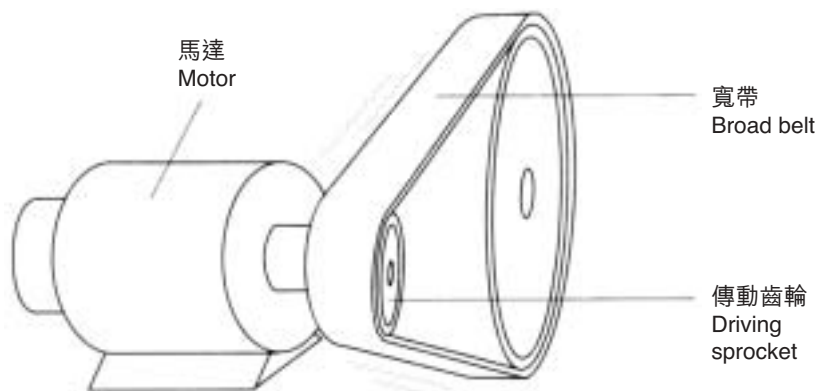


圖11 消減收集物料的漏斗衝擊噪音的處理
Figure 11 Treatment to reduce impact noise of collection hopper



解決方法
SOLUTION

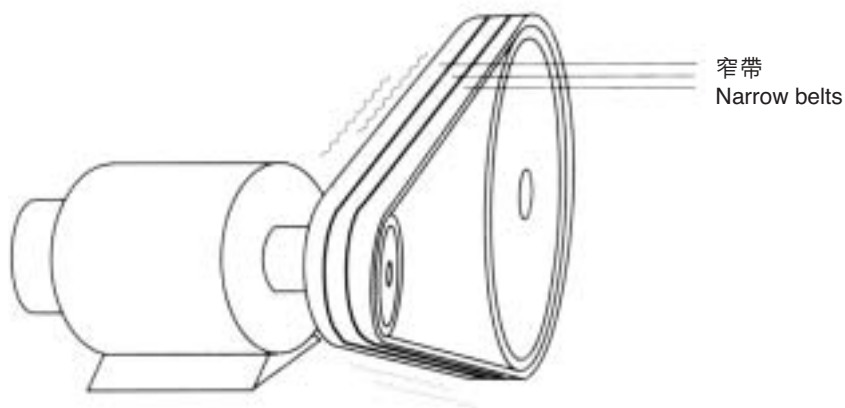
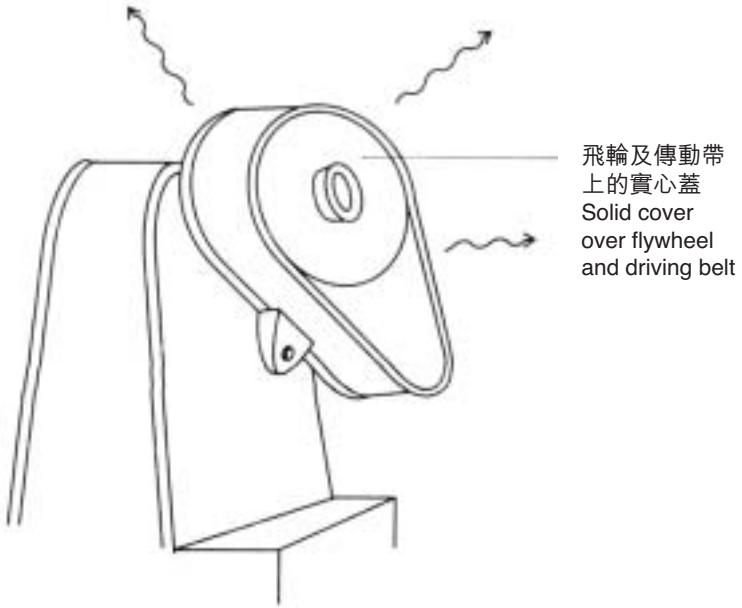


圖12 使用窄帶減低寬帶的震動面
Figure 12 Reducing the vibrating surface of a broad belt by narrow belts



解決方法
SOLUTION

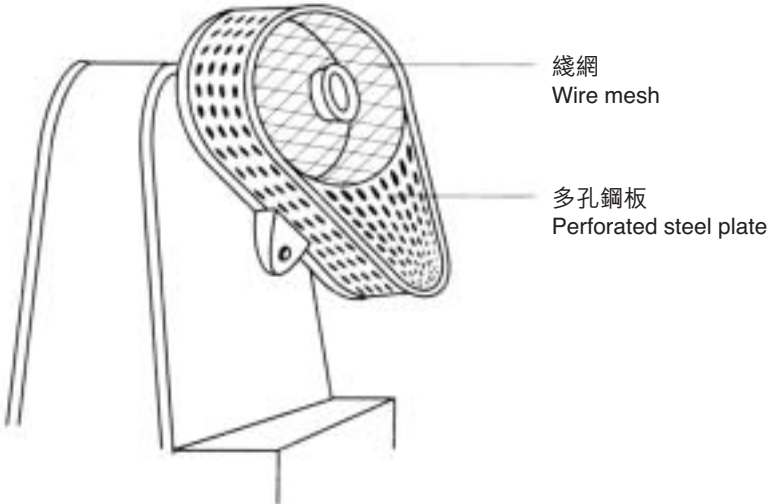
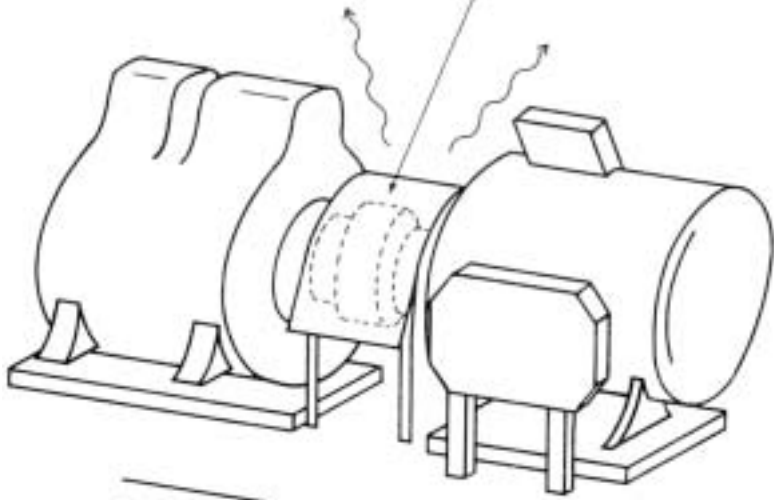


圖13 使用綫網代替飛輪蓋
Figure 13 Replacing a flywheel cover by wire mesh

普通鋼片的覆蓋
Cover of ordinary steel sheet



解決方法
SOLUTION

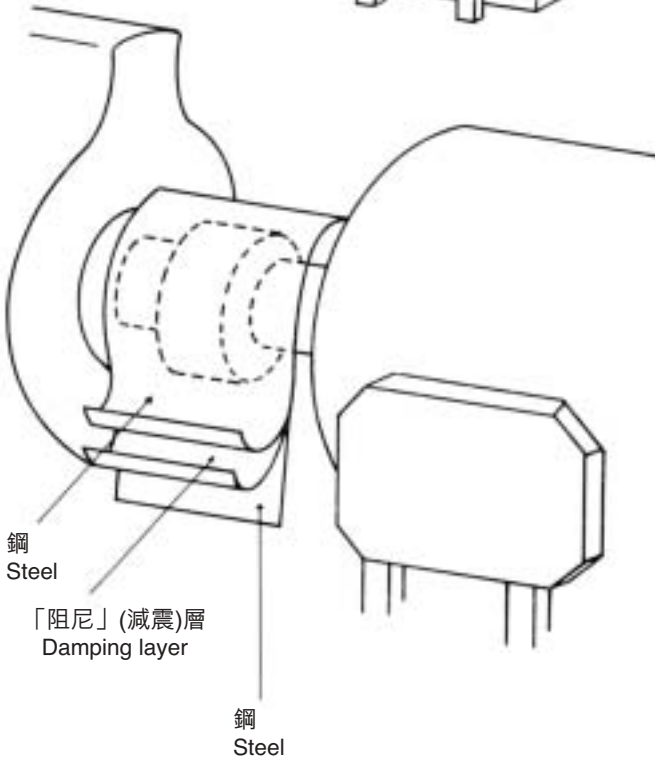
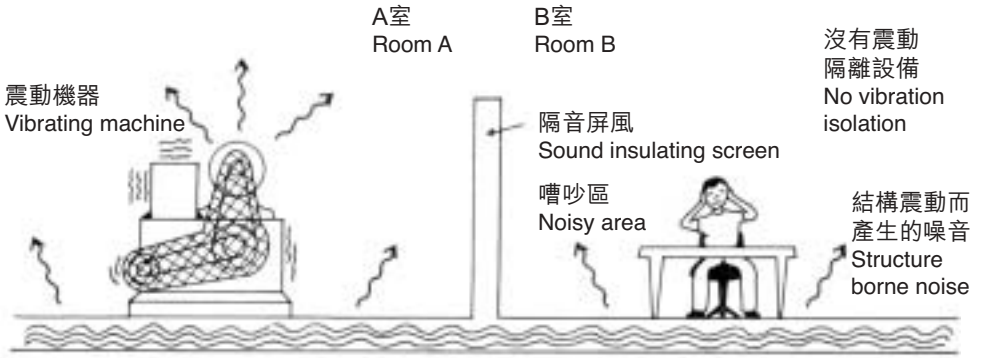


圖14 泵的外罩
Figure 14 Enclosure for pump



解決方法

SOLUTION

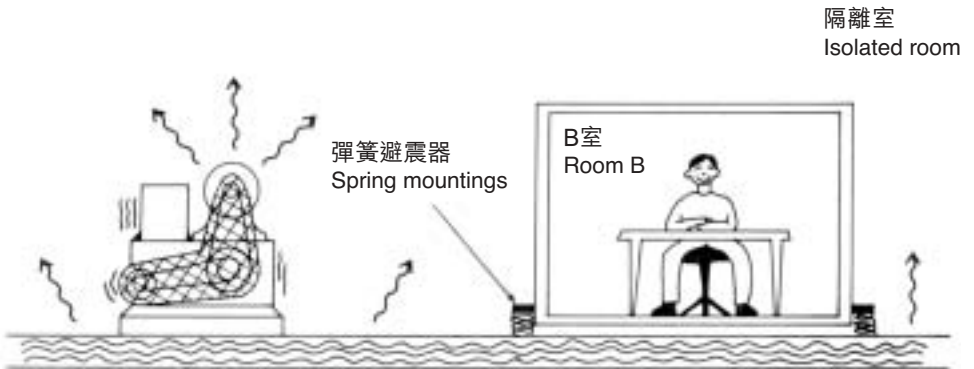
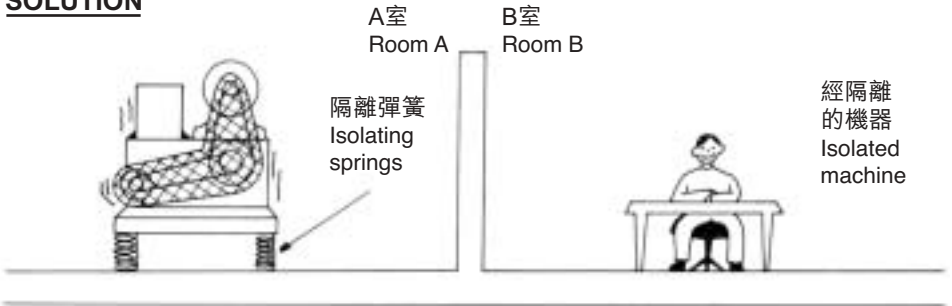


圖15 防震隔離器及隔離室
Figure 15 Anti-vibration isolators & isolated room

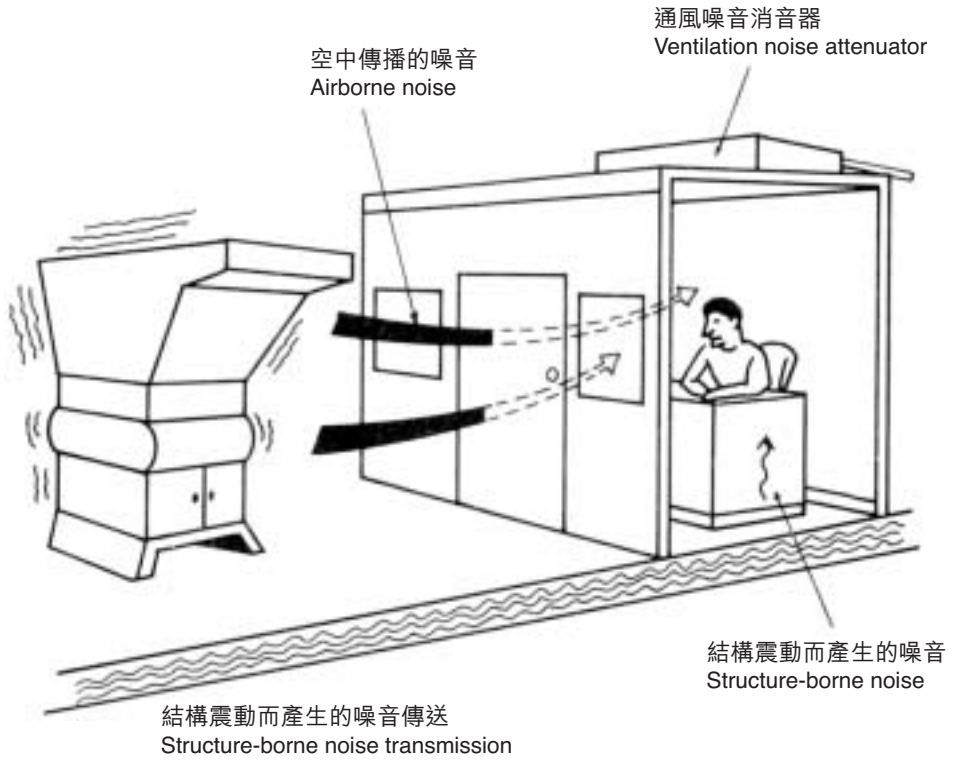
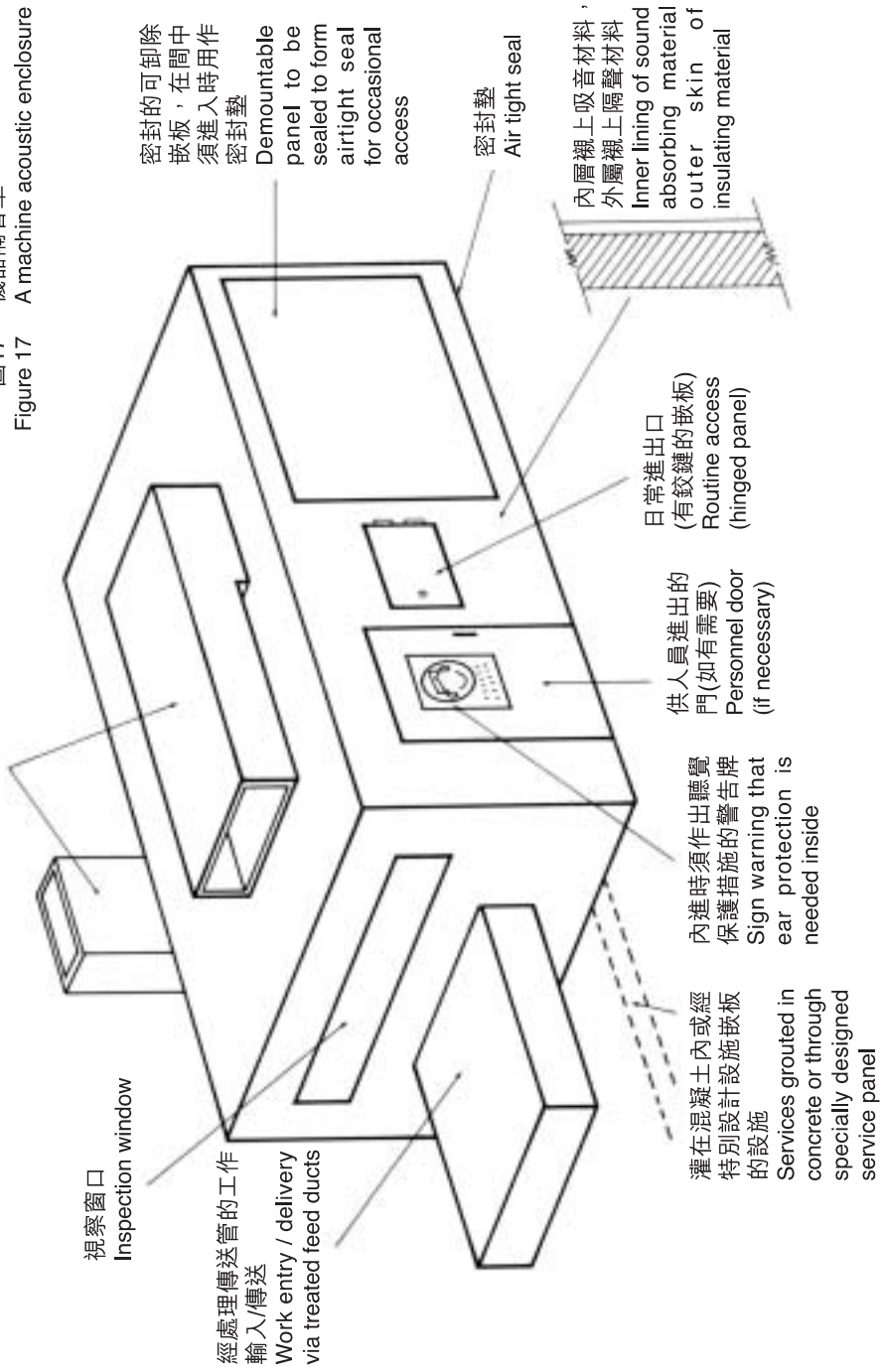


圖16 為僱員提供的噪音隔離室
Figure 16 A noise refuge for employee

經適當消音的冷凝空氣進氣/排氣口
Suitably attenuated cooling air supply discharge

圖 17 機器隔音罩
Figure 17 A machine acoustic enclosure



視察窗口
Inspection window

經處理傳送管的輸入/傳送
Work entry / delivery
via treated feed ducts

密封的可卸除嵌板，在閘中須進入時用作密封墊
Demountable panel to be sealed to form airtight seal for occasional access

密封墊
Air tight seal

日常進出口
(有鉸鏈的嵌板)
Routine access
(hinged panel)

供人員進出的門(如有需要)
Personnel door
(if necessary)

內進時須作出聽覺保護措施的警告牌的設施
Sign warning that ear protection is needed inside

灌在混凝土內或經特別設計設施嵌板的設施
Services grouted in concrete or through specially designed service panel

內層襯上吸音材料，
外層襯上隔聲材料
Inner lining of sound absorbing material
outer skin of insulating material

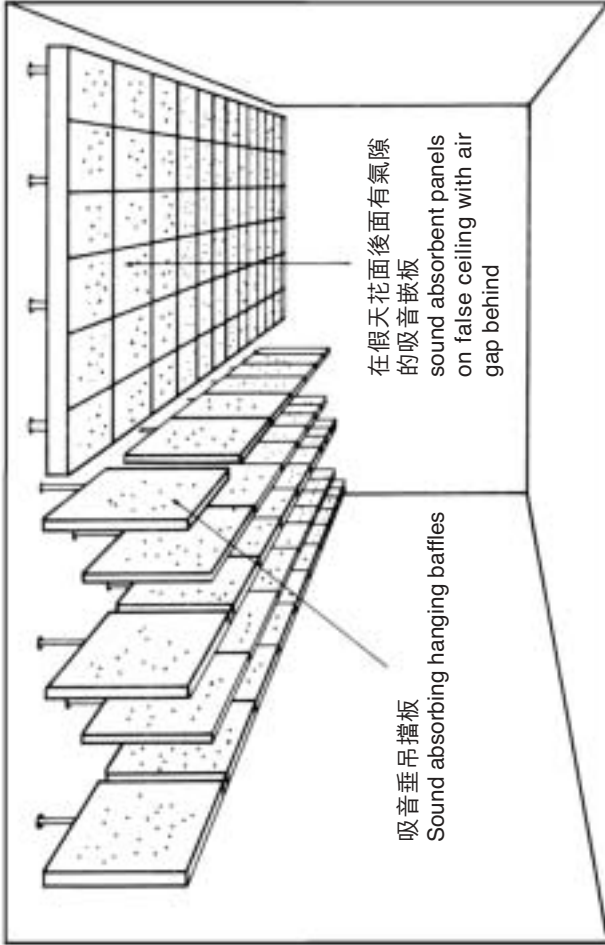
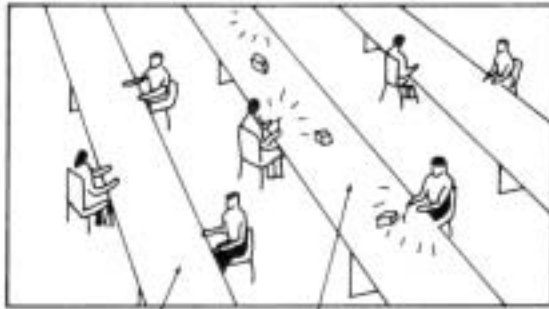


圖 18 吊板吸音器
Figure 18 Hanging panel absorbers



生產綫工場
Assembly workshop

較安靜的生產綫
Relatively quiet line

嘈吵的生產綫
Noisy line

吸音擋板
Sound absorbent baffles

解決方法
SOLUTION



吸音屏風
Absorbent screen

圖19 吸音屏風和擋板
Figure 19 Absorbent screens and baffles

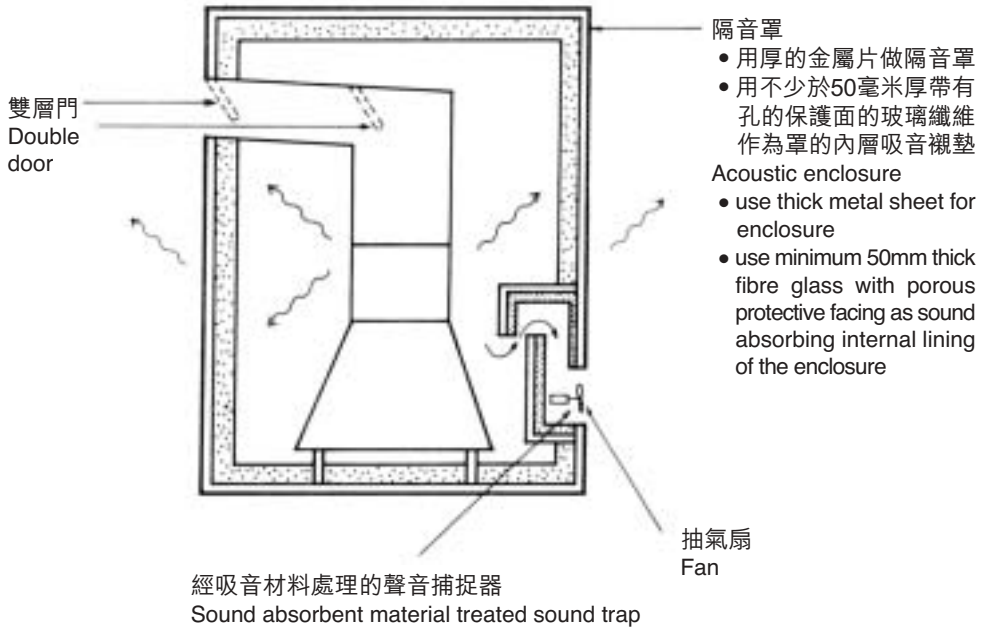
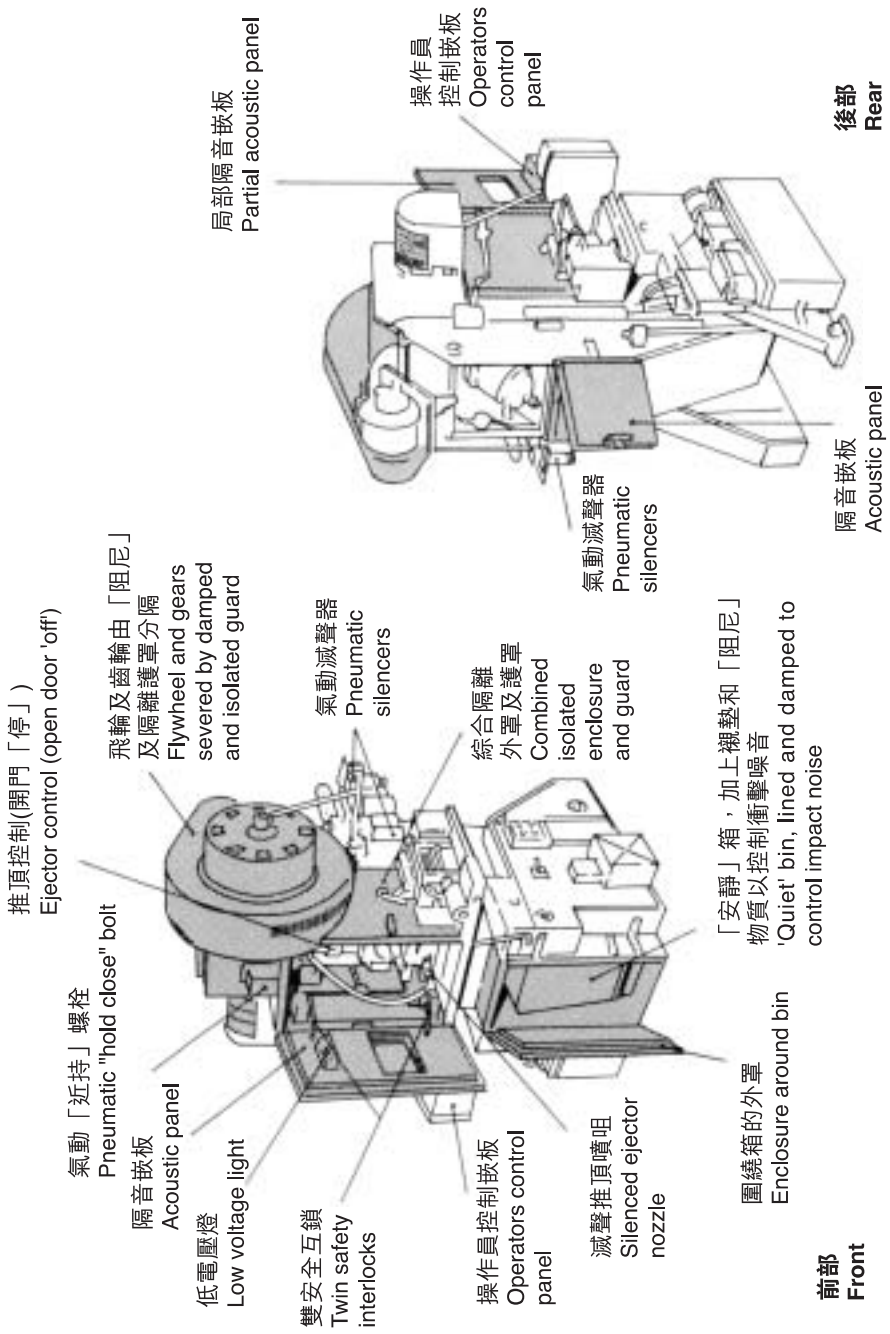


圖20 塑膠碎料機的隔音罩
Figure 20 An enclosure for a plastic granulator



經處理區域 Treated area

註：啤機下裝上防震器
Note: Anti-vibration mountings under the press

圖21 五金啤機採用的噪音控制措施
Figure 21 Application of noise control measures to power press

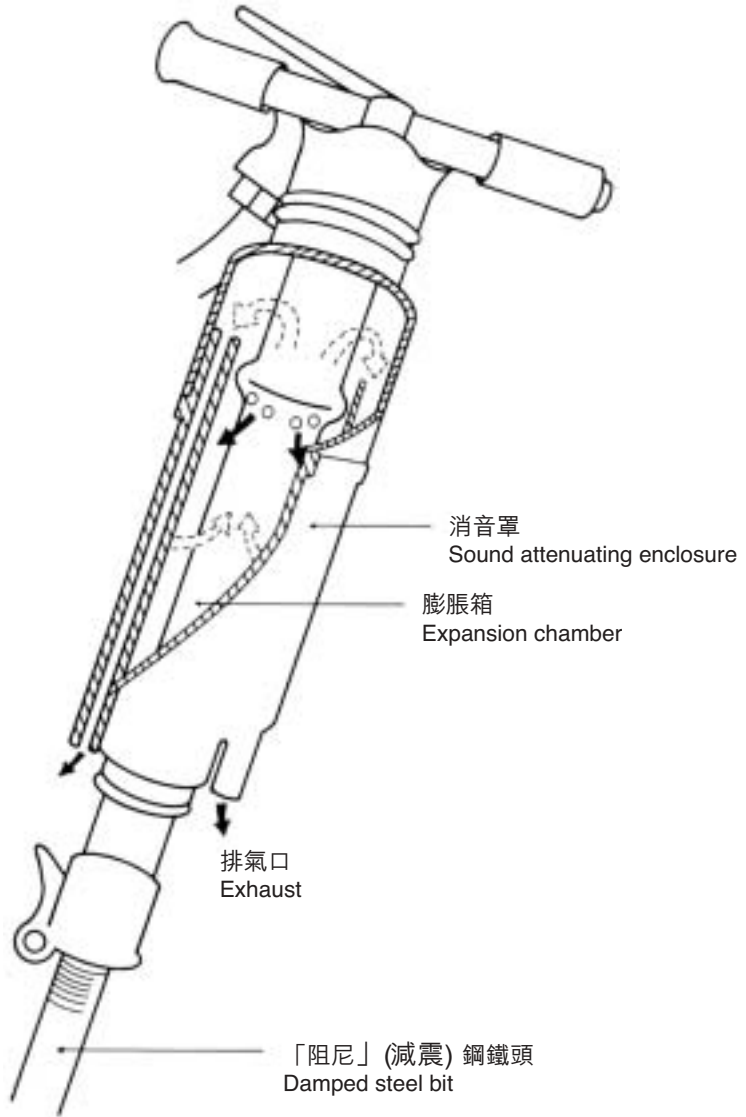
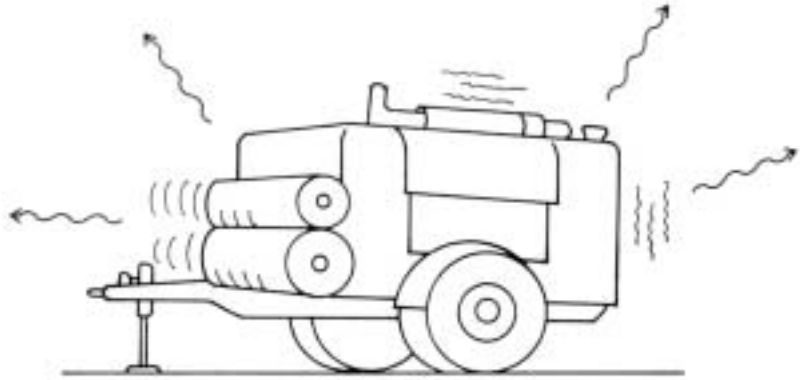


圖22 手提氣動混凝土破碎機
Figure 22 Portable pneumatic concrete breaker



沒有隔聲的壓縮機
Uninsulated compressor

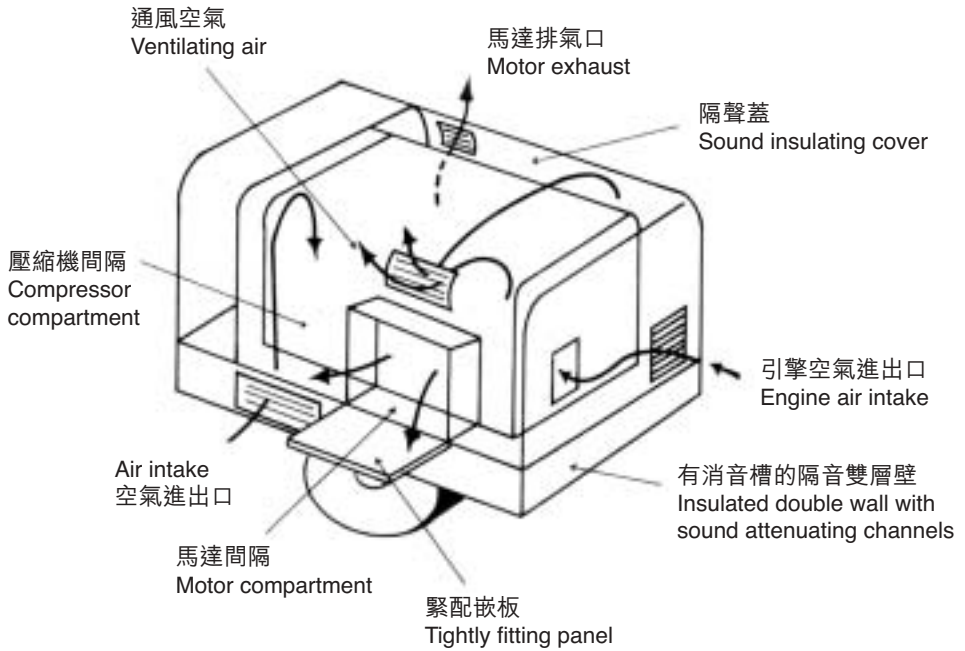


圖23 空氣壓縮機的隔音蓋
Figure 23 Acoustic cover for air compressor

