continuous front and back exposures. For continuous wear the apron or sandwich width should be limited to 14 to 18 in. to assure adequate continuous side openings for air circulation and body ventilation. In addition gauntlets and face shields are particularly applicable to operations such as the pouring and casting of hot metals. Supply houses dealing in safety clothing for industry offer suitably lightweight flame proofed foil-faced cotton drill or denim of excellent reflectivity.

For repairs inside hot coke ovens and industrial furnaces, a complete suit is available using forced ventilation from a small blower or a compressed air source. These suits may be made of asbestos cloth, faced with a reflective metal in atomized form.

If the shield is a good reflector, it will remain relatively cool in the presence of severe radiant heat. This reflectivity is a surface characteristic. Hence a thin sheet is as effective as a thick one. Tinplate, stainless

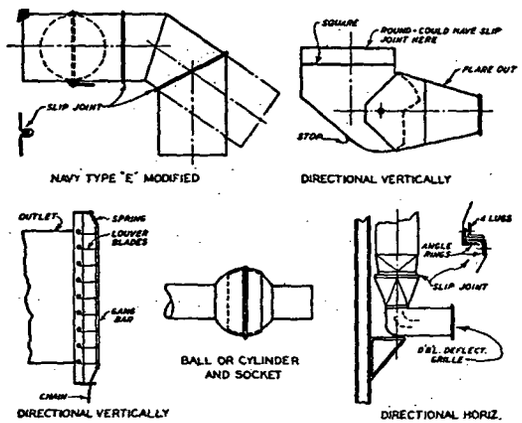


FIG. 1. DIRECTIONAL OUTLETS FOR SPOT COOLING

steel and ordinary flat or corrugated aluminum sheets are efficient and long-lived. Foil-faced plaster board, though less durable, obtains good reflectivity on one side.

Spot Cooling By Air Motion

The previous paragraphs have described the steps which should be taken to reduce the heat load on the worker or the work area. When these factors have been considered and the heat load has been minimized to a practical degree, the designer may then resort to spot cooling by air motion to cool the worker himself. Such cooling may be provided by supplying air to the local areas or into suitable working enclosures or booths, or to ventilated coverall suits. The air supplied should be at such conditions of temperature, relative humidity and air motion as to provide a cooling effect on the worker.

These systems may also be used to provide make-up air for industrial exhaust systems, or to provide spot heating in the winter time.

Such installations may be provided to improve the conditions around the

worker continuously, or else to provide a relief area where the worker will be in a cool zone intermittently. The designer should keep this in mind in selecting the proper method of air cooling.

Spot cooling may be provided by means of recirculated (man-coolers), direct outside, dehydrated, evaporatively cooled or mechanically cooled air, the solution depending upon the environmental conditions existing in the working area, and the economic factors. Generally, recirculated air will be effective only for areas of moderate heat release. Other systems will be required for areas having high heat release.

A great variety of outlets may be used for spot cooling. Several different types are shown by Fig. 1. In addition, several manufacturers make remotely adjustable ceiling diffusers such that the air patterns may be altered from horizontal (parallel to the ceiling) to vertical, down. A number of manufacturers also make double deflection grilles that are good for this service. Such outlets can be provided in conjunction with an elbow type outlet and slip joint (see lower right diagram in Fig. 1) so as to provide directional discharge at any desired angle. The latter is very important to the worker because he may frequently want the air discharging into the space but may not want it to blow on him.

Perforated panels may also be used for the supply air. Such panels have low induction characteristics and, used in conjunction with a booth could provide a low velocity blanket of air which should be effective for local heat relief, if supplied with cooled air. A booth would shield the worker from radiant heat and would permit effective cooling by means of the air supplied through the panel.

The outlet air velocities used for spot cooling systems may vary from 50 to 2000 fpm. The higher velocities are frequently used but should be used with caution as noted hereafter. The data in Chap. 31 Air Distribution, should be studied in determining the required outlet velocities corresponding to the desired velocity at the worker or the operating station.

The following items are particularly important in designing spot cooling installations:

1. Where the personnel are engaged in work requiring little activity and where the exposure is continuous, the air velocity at the personnel should be low, approaching the normal room velocities. The maximum velocity for such cases is sometimes given as 200 fpm. With greater worker activity and where the worker is in the air current intermittently, higher velocities may be used. See Chap. 6, Effective Temperature Chart, Fig. 9.

2. Generally the temperature of the air impinging on the worker should exceed 80 F.

3. When the temperature of the air impinging on the worker exceeds the skin temperature the critical point is approached where too high an air velocity will add to the body heat load and too low a velocity will fail to remove the sweat, and thus fail to provide the maximum evaporative cooling for the existing conditions. (See Ref. 2.)

4. The outlets should be placed as close as practicable to the worker in order to take advantage of the lower discharge air temperature and the relatively larger core of air at the discharge air temperature. Installations in which the air is discharged from outlets 4 to 8 ft. from the worker are effective with small volumes of air, 200 to 1000 cfm. per outlet. At hot metal furnace working stations, 2000 to 3000 cfm. will be adequate. At greater distances more air is required due to the increased entrainment of room air. However, the effect of the lower velocity air would be more tolerable.

5. In selecting the outlets it should be kept in mind that large outlets have greater cooling effect because of the larger core of cool air. Slot outlets by comparison have high induction ratios, thus higher impinging temperature (at the worker). Per-