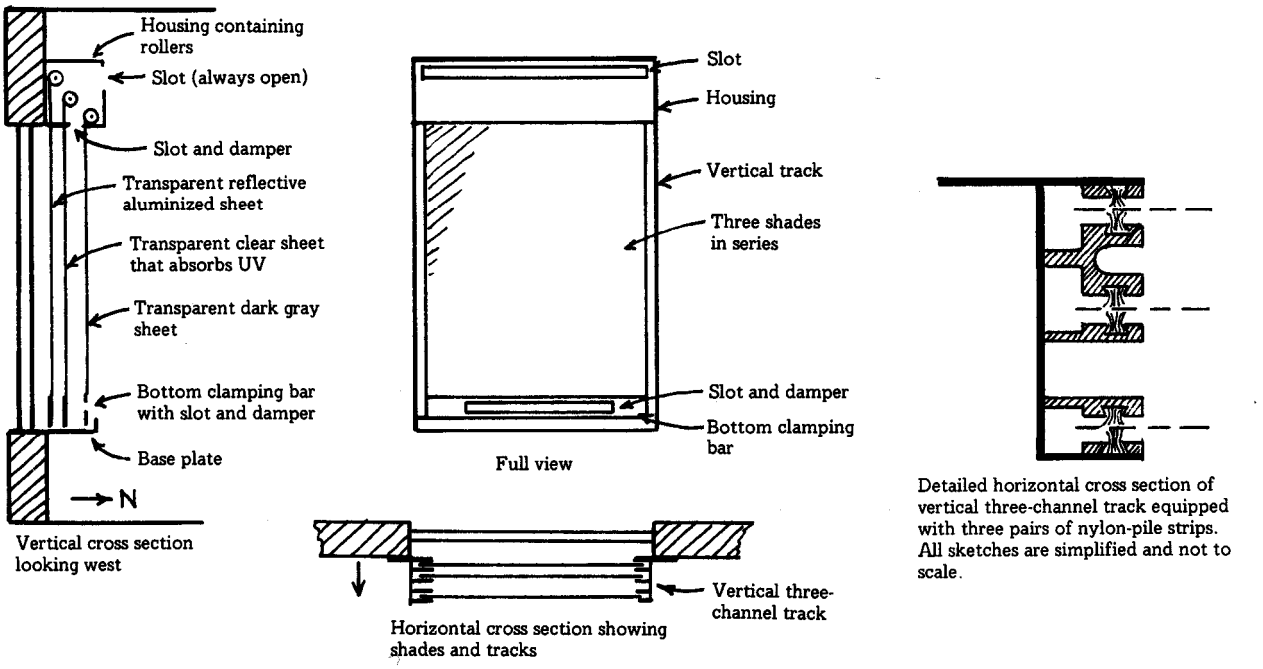
INDOOR, THREE-SHEET, THREE_ROLLER SHADE SYSTEM (INSEALSHAID MADE BY ARK-TIC-SEAL SYSTEMS INC.) (Scheme 18.6)

This device, made by Ark-Tie-Seal Systems Inc. and called *Insealshaid,* can operate in several modes and provide several benefits in addition to insulating the window at night.

There are three shades, three rollers, multi-channel vertical tracks, a housing, and other components. All three shades are transparent. Each consists mainly of polyester and is attached to a roller within the housing. The north shade is dark gray (60% to 70% absorbing). The intermediate shade is optically clear (but with a slight gold cast) and transmits virtually no ultraviolet radiation. The south shade includes a vacuum-deposited aluminum layer between laminated films of mylar and reflects 80% of the incident solar radiation. This shade is 0.0035-in. thick. The others are 0.005-in. thick.

Each vertical edge of each shade moves up and down within one channel of a vertical threechannel track of extruded aluminum. Each channel includes opposed strips of nylon pile that form a fairly tight seal. Additional pairs of pile strips situated close below the rollers provide seals at the topofthe window. The lower edge of each shade terminates in a bottom clamping bar to the underside of which a 1/4-inch-diameter compressible plastic tube is secured to provide a seal against the common horizontal base plate. Thus all four edges of each shade are well sealed.

At the top of the system there is a housing which encloses the three rollers. The housing is designed so that when a damper in the base of the housing is open, air from the space between the



north shade and the intermediate shade can flow upward into the housing via a long slot and can then emerge into the room via another long slot in the housing's north face. The damper, which is of extruded aluminum and is centrally pivoted, is controlled by a bimetallic strip which opens the damper when the temperature reaches about 85°F. How does room air enter the space between the north shade and the intermediate shade? Via a slot in the clamping bar at the base of the north shade. On the south side of this slot there is another bimetallic-strip-controlled damper; this opens when a specified temperature is reached, such as 70°F.

The south shade may be raised or lowered manually, with the aid of a pulley and a nylon cord, without the need to first raise the other shades.

Although most cost effective when applied to a single-glazed window, the system is applicable also to double-glazed windows. The shade system may be mounted within the window recess if this is several inches deep; otherwise it is mounted against the fixed frame of the window.

Many operating modes are available:

During cold winter nights, use all three shades and thus greatly reduce heat-loss.

During sunny days in winter,

use no shades; allow much solar radiation to penetrate deep into room, or

use the north and intermediate shades so that the air between these shades will become hot and will circulate (via top and bottom vents) to the room, or

use just the intermediate shade-to admit solar radiation but reduce conductive loss of heat.

During winter days with intermittent clouds, use the north and intermediate shades so that when the sky is cloudy, the shades and closed vents will provide a high degree of insulation, and when the sky is clear much hot air will be delivered to the room via the top and bottom vents.

During hot sunny days in summer, use the intermediate and south shades; together they exclude 80% of solar radiation and reduce conductive inflow of heat.

At all times when glare is a problem or excessive ultraviolet radiation may cause curtains, rugs, etc., to fade, use the intermediate shade, which transmits no ultraviolet radiation. Some persons may choose to use this shade at all times-night and day, summer and winter -to protect rugs, curtains etc., and to reduce conductive flow of heat.

Cost: About $7.50 per ft^2 F.o.B., for a typical window. This cost includes shades, rollers, tracks, housing, dampers, etc., but not installation.

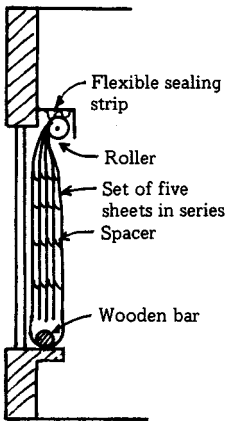
INDOOR FIVE-SHEET SHADE (MADE BY INSULATING SHADE CO., INC.) (Scheme lB.7)

This remarkable shade, capable of very great reduction in heat-loss, was developed by Insulating Shade Co., Inc., of Branford, Conn. It was demonstrated at a 9/9/77 exhibition in Hartford, Conn., and was featured in the January 1979 issue of *Popular* Science Monthly.

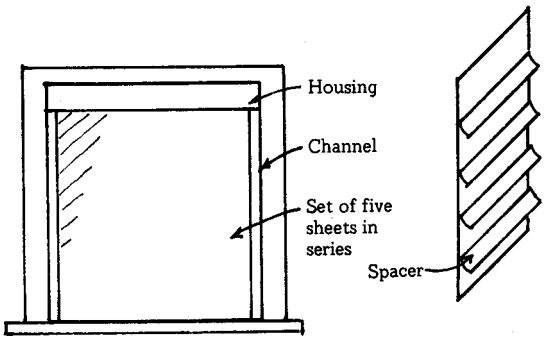
Although the shade includes five sheets in series, there is but one roller, for example a 1 1/4-inch-diameter wooden roller with internal helical heavy-duty wind-up spring and an automatic latch (pawl).

Of the five sheets, the (front and back) outermost ones are of vinyl plastic that has an aluminum coating on the innerside. The three interior sheets consist of plastic that has been al uminized on both sides. Thus there are 8 aluminum layers in all. At the top, all five sheets are secured to the roller. At the bottom, the two exterior sheets are joined to form a kind of envelope or bag. The bottom of the envelope contains a horizontal wooden bar that provides stiffness and weight.

When the shade has been pulled down (to cover the window), spacers come into play to maintain spaces of about 1/2 in. between the sheets. Each spacer is a plastic strip about 1 1/2-in. wide and as long as the shade is wide. In cross



Vertical cross section looking south. The thickness of the set of sheets is greatly exaggerated



Full view looking south

Perspective view of four spacers on one sheet

section the spacer is curved, having about the same curvature as the surface of the roller. Spacers are affixed to four of the sheets, and on each of these the spacers are about 7 in. apart on centers. Besides keeping the sheets 1/2 in. apart, the spacers serve as partitions to divide the space between adjacent sheets into several subregions. The overall thickness of the set of shades is about 2 to 21/2 in.

The right and left edges of the shade assembly are confined within vertical channels, or boxes, 21/2 in. in inside width. The bottom of the envelope, with a compressible sealing strip attached to it, rests on the window sill. The gap above the roller is closed by means of a pair of flexible sealing strips attached to the upper part of a canopy, or housing, that contains the roller.

When the shade is rolled up, all five sheets roll on the one roller. The spacers, having curvature matching that of the· roller, occupy almost no space; thus the entire rolled-up assembly is only about 23/4 in. in diameter.

To close the shutter, one pulls down strongly on a cord attached to the center of the bottom of the envelope. To open the shutter, one gives a jerk to the cord and then pays it out at a moderate speed (about 1 ft/sec) as the spring within the roller rolls up the set of sheets automatically.

Cost: The cost of a complete system for a 5foot-wide, 6-foot-high window, including shade proper, roller, side channels, top housing, and sealing strips for top and bottom is about $110, not including installation, Le., about $4/£1^2• (?)

Cost of the shade alone: about $2. 75/ft^2 .

Comment

The system enormously reduces radiation and conduction losses. Tn tact on'e may wonder whether, with four air spaces and eight aluminumcoated surfaces, the shade is not overdesigned. As regards convection: the edge seals are comparable to those of some of the other high-performance thermal shades; yet one may wonder whether the seals are tight enough to significantly reduce inleak or out-leak of air through a leaky window.

Limitations

The cost is high.

Considerable labor is involved in installing the device.

There is a possible need to widen the window sill to accommodate the very thick shade.

Some persons may not like the appearance of the side channels and top housing.

If the shade is allowed to roll-up very rapidly, air is trapped between the various sheets, causing them to billow out.

The shade (with its wooden bar at the bottom) is so heavy, and the wind-up spring so strong,

that raising and lowering the shade is somewhat difficult.

One may wonder whether such a relatively complicated system will last for many years without deterioration.

As of July, 1979, some of the key components (side channels) were not available.

INDOOR, FOUR-SHEET, ROLL-UP, SELF-INFLATING SHADE (INSULATING CURTAIN WALL) (Scheme 18.8)

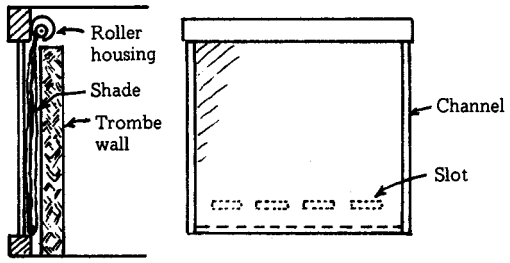
This unique device, invented and patented by Ronald Shore of Thermal Technology Corp., has the registered name *Insulating* Curtain *Wall.* Sometimes it is called *Self-Inflating Curtain.* It is intended for use with large-area windows in cold climates and is well suited for use with Trombe walls or other structures that will impart heat to one side of the curtain on winter nights. An excellent description of the device appears in *Popular* Science of October 1979, p. 99.

There are four sheets mounted on a single 3inch-diameter roller. Each sheet is *D.DD4-in.* thick. The outer sheets are of polyester on which aluminum has been vacuum deposited, and a layer of rip-stop nylon cloth is included. The nominal reflectance of the aluminum layer is 93%. The inner sheets, which include aluminized fabric, have a nominal reflectance of 68%. The aluminum layers are on the south side of the south sheet and the north sides of the other sheets.

At the sides of the window there are 5-inchwide vertical channels which confine and guide the edges of the shade.

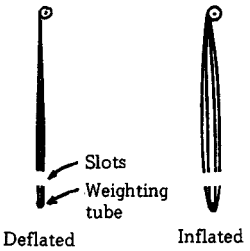
The two outermost sheets of the shade are joined at the bottom to form a kind of bag. Near the bottom of the bag there are several horizontal slots (in all four sheets) that permit air to enter or leave. Each slot is 3D-in. long and 3-in. wide. Included in the bottom of the bag is a 11/2-inch-diameter tube that weights the bag down and helps form a tight seal against the window sill.

The roller is turned by a small electric motor situated within one end of the roller. The enclosing cylindrical housing is 6 to 8 in. in diameter.



Vertical cross section of shade and Trombe wall

Full view of shade alone, looking south



Vertical cross section shade: deflated and inflated. The thickness is exaggerated.

The shade has a unique self-inflating capability. Specifically, its thickness increases greatly, growing from a fraction of an inch to about 5 inches finally, when and if the air within it is hotter than the air adjacent to it. When the shade is inflated, there are air spaces 1/2- to I-in. thick between successive sheets.

Why does the set of sheets expand'? One might guess the reason to be that air, when heated, expands. But this is not a correct explanation, because any such expansion would amount to only a fraction of an inch. The correct explanation is one that I explained in a letter of about Dec. 15, 1977, to Ronald Shore. A chain reaction occurs when the air within the shade is hotter than the adjacent unconfined air. When the confined air is hotter, it is less dense: a 5-foot-high column of such air weighs less than a similar column just outside the shade, and accordingly the pressure along the vertical centerline of the confined column is more nearly uniform than the pressure along the vertical centerline of the unconfined (cooler, more dense)

column. Thus if the pressures at the bases of the columns (near the slots) are equal, then the pressures at the tops of the columns are unequal; specifically, the pressure at the top of the confined column exceeds that at the top of the unconfined column. Consequently the air in the upper part of the confined column (and in the upper region of the shade as a whole) tends to expand, pushing the walls of the bag outward. In summary, the thickness of the bag increases-and at the same time additional air flows into the bag, via the slots near the base, to accommodate this increase in volume of the shade. The newly introduced air in turn becomes hotter, and less dense, and accordingly the tendency of the bag to expand continues. As the bag expands, more and more air enters via the slots. The process continues until the stiffness or weight of the bag, or the confining effect of the side channels, stops further expansion.

Comment

The three air spaces defined by the expanded set of four sheets discourage heat-flow by conduction and the four aluminized layers discourage energyflow by radiation. When the assembly expands and presses against the adjacent vertical surface or surfaces, excellent face seals exist. In summary, the thermal performance of the shade is excellent. The R-value is said to be about 5 before the shade is inflated and twice as great when inflation is complete.

The shade can be used in summer to exclude energy. The shade is lowered, and solar radiation heats it and makes it expand.

Cost: For a large window, such as one 20-ft wide and 13-ft high, the shade costs $4.50/ft2, retail, F.G.B., not including side channels. For an 8-foot-wide, 6-foot-high window the cost is about $8/ft^2.

Limitations

The device is not recommended for use on small windows.

There are situations in which little or no inflation occurs. But even then, thanks to the many aluminized sheets, a fairly high degree of insulation is provided.

INDOOR, TWO-SHEET, TWO-ROLLER SHADE SYSTEM THAT CAN CONSTITUTE A DUCT THAT FACILITATES SOLAR HEATING (Scheme 18.9)

If, adjacent to the double- (or single-) glazed window, there are two roll-up shades, the designer can arrange for the two shades, when unrolled, to form the two main sides of a vertical duct. If at least one of the shades is dark colored, it may absorb much of the solar energy passing through the window, and the resulting heat may be transported, by natural or forced flow of air in the duct, to the room as a whole or to a thermal storage system (say in the attic or basement). Dampers, operated manually or automatically, may be employed to direct the hot air from the duct to the room or to the storage system.

If the shades are rolled up, the incoming solar energy penetrates deep into the room, heating it promptly.

At night the rolled-down shades reduce heatloss through the window.

In summer the rolled-down shades can be used to exclude solar radiation, especially if the south face of the south shade is aluminized. If it is not aluminized and the air between the shades becomes very hot, this air may be vented to the outdoors; the venting may assist the inflow, elsewhere, of cool outdoor air.

Many persons have invented schemes of this general type and there are many published articles on the subject. (See, for example, U.S. Patent 3,990,635 of 11/9/76 by J. W. Restle, A. J. Algaier, and G. R. Krueger.)

I describe no specific system in detail because (a) any such scheme is somewhat complicated and (b) the variety of systems that may be proposed is enormous. Furthermore, various between-glazings modifications may be proposed and also various modifications involving rigid plates.