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Weatherproofing MICHIGAN HOMES

By C. H. JEFFERSON

One method of weatherproofing homes is to pour a filltype insulation between attic floor joists. Such material can be easily worked around electrical wiring as shown.

MICHIGAN STATE COLLEGE
EXTENSION SERVICE
EAST LANSING

SUMMARY

Most of the information given in this bulletin applies primarily to the insulating of existing houses, but it should be obvious that the general principles can also be applied to new construction, where the choice of materials and facilities for installation are less limited.

In general, the things that should be emphasized are:

(1) Insulation is desirable for existing dwellings as well as for new ones owing to (a) fuel saving, (b) improved living conditions, and (c) lower cost of installing or maintaining a heating plant.

(2) Insulation should be applied first to the parts of a house where heat loss is greatest. Therefore, storm windows and weather-stripping should be added first, then insulation in the attic and, if desirable, the side walls could be insulated last.

(3) Each house, particularly existing houses, represents an individual problem, depending upon type of construction, type of installation of electrical wiring, etc.

(4) Financial justification is shown by a comparison of the savings in fuel cost and cost of owning the insulation. Additional amounts of insulation may sometimes be desirable for additional comfort.

Michigan State College and United States Department of Agriculture cooperating, R. J. Baldwin, Director of Extension Service, Michigan State College, East Lansing. Printed and distributed under acts of Congress, May 8 and June 30, 1914.

Weatherproofing Michigan Homes

By C. H. JEFFERSON

Weatherproofing in some form is now recognized as an important item in house construction. Most new houses are weatherproofed at the time of construction, but many old houses in Michigan waste fuel at an alarming rate through windows, through cracks around windows and doors and through uninsulated ceilings, walls and floors. In addition to fuel conservation which is important at the present time owing to labor and transportation shortages, weatherproofing dwellings improves living conditions by:

1. Maintaining more comfortable temperatures in the home during the winter and summer.
2. Permitting a higher relative humidity of inside air without condensation on walls and windows.
3. Maintaining atmospheric conditions in the home which may tend to reduce respiratory disturbances.

Other advantages are:

4. Less labor to fire furnace.
5. Definite decrease in fuel consumption.
6. Lower maintenance costs for heating plant.

Since the primary purpose of weatherproofing is to retard the passage of heat either from the inside in winter or from the outside in summer it seems desirable to know something about how heat travels, and how it escapes from a heated building.

FACTS ABOUT HEAT

Heat travels in three distinct ways: radiation, convection, and conduction.

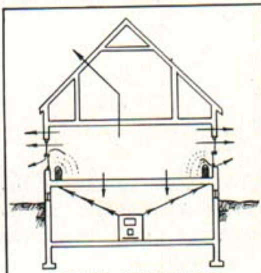
Radiation is the method by which heat travels through air or through a transparent material such as glass without noticeably increasing the temperature of either the air or the glass. An excellent example is the heat from the sun which reaches the earth by radiation without heating the space through which it travels.

Convection is the method by which heat is carried by the circulation of gases or liquids such as air or water. As an example, the air around a heating stove becomes warm. This warmed air expands and rises, permitting air which has been cooled by contact with outside walls and floor to flow in to take its place around the stove. This cold air is warmed and rises, and this process continues until the temperature of all the air in the room approaches a constant temperature.

Conduction is the method by which heat travels through any solid substance. If one end of an iron bar is held in a forge fire, it soon becomes red hot. Each particle in contact with adjacent heated particles is warmed by conduction until the entire bar becomes heated. Heat passes through some materials less rapidly than through others, and those that offer a high degree of resistance to the passage of heat are called insulating materials.

METHODS OF WEATHERPROOFING

By applying this information on heat transmission it is possible to understand how heat travels from the furnace to the various parts of the house and how it escapes through all outside surfaces. In addition to the heat which passes directly through wall and roof



HOUSE HEAT LOSS

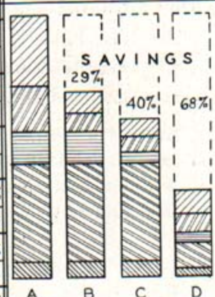
AVERAGE 6 RM. HOUSE:
700 SQ. FT. - CEILING & ROOF
1500 SQ. FT. - WALL
170 SQ. FT. OF GLASS
17 WINDOWS 3 DOORS

HEAT LOSS DISTRIBUTION B.T.U. & % OF TOTAL

PART OF HOUSE		CONSTRUCTION A	B	C	D
AIR LEAKAGE	% OF TOTAL	26%	11%	13%	25%
	1000 B.T.U.	12.8	4.0	4.0	4.0
GLASS	% OF TOTAL	18%	11%	13%	24%
	1000 B.T.U.	9.65	3.82	3.82	3.82
ROOF & CEILING	% OF TOTAL	13%	19%	5%	10%
	1000 B.T.U.	6.9	6.9	1.55	1.55
WALLS	% OF TOTAL	37%	51%	61%	30%
	1000 B.T.U.	18.3	18.3	18.3	4.88
FLOOR	% OF TOTAL	6%	8%	8%	10%
	1000 B.T.U.	2.38	2.38	2.38	1.68
TOTAL HEAT LOSS		100%	100%	100%	100%
		50.03	35.40	30.05	15.93

HEAT SAVING FROM WEATHERPROOFING

BAR GRAPH



A NO INSULATION, WEATHER-STRIP, OR STORM WINDOWS.

B WEATHER-STRIP & STORM WINDOWS NO INSULATION.

C WEATHER-STRIP, STORM WINDOWS, & ATTIC FILL INSULATION.

D COMPLETE WEATHERPROOFING

Fig. 1. Where heat escapes.

areas a large amount is lost by air leakage through cracks and around door and window openings. The diagram in Fig. 1 shows these various avenues of escape and indicates the relative amounts of heat lost through each.

From a study of this chart one obtains a better understanding of the relative importance of various methods of weatherproofing and insulating a dwelling. For example, approximately 44 percent of the total heat lost from a non-weatherproofed dwelling escapes through cracks around door and window openings and through the doors and windows themselves.

Many houses have more window area and the heat loss would be even greater than shown. It is obvious that glass is a very poor insulating material and that the rate of heat loss through and around the windows is greater than from other parts of the house.

It is more difficult to make a direct comparison between the relative amount of heat lost through the wall, exclusive of doors and windows, and that lost through the roof or ceiling owing to variations in types of construction, amount of these areas exposed and the difference in temperature maintained in various parts of the house. In computing the data for this chart a uniform inside temperature was assumed and no allowances were made for unheated bedrooms or for the difference between the temperature at the floor and at the ceiling.

If however, the rooms on the second floor are only partially heated, a greater percentage of the total heat loss will be through the walls.

It is apparent that these factors will vary with individual houses and the method of weatherproofing and insulating any house will vary accordingly. But regardless of the relative heat loss through the outside walls and ceiling it is usually more practical, at least in existing houses, to insulate the attic before insulating the outside walls owing to the fact that the attic is more accessible and the insulation can be added with considerably less labor and expense.

It is difficult to determine just what heat conservation may be effected by weatherproofing doors and windows and applying attic insulation, but approximate estimates show air leakage reduced nearly 75 percent by weatherstripping, loss through windows reduced about 50 percent by storm windows, and loss through ceiling and roof reduced from 50 to 60 percent by 3 inches of attic insulation. These combined savings represent from 40 to 50 percent of the total heat loss from a non-weatherproofed house.

The obvious place to start with any weatherproofing program would be where the rate of heat loss is greatest and where the saving in heat for each dollar invested in insulation is also greatest. For this reason, storm windows and weatherstripping around all doors and windows are suggested as the first step in weatherproofing an old house, followed in order by attic insulation and, if desirable, by insulation of the side walls. Some heat may be lost through the floor but insulation for the floor or basement ceiling is probably impractical except in special cases.

WEATHERPROOFING WINDOWS AND DOORS

Storm windows, properly fitted, will reduce the loss of heat through window areas by approximately one-half. By reducing heat loss through window areas, the inside temperature near these areas is raised and uncomfortable drafts are less noticeable. Condensation on windows is also reduced by the application of storm sash.

It is desirable, however, to fit storm windows loosely to prevent damage to window casings as the storm sash swells and also to provide openings for the circulation of air from the space between the two windows to the outside. If condensation does occur between the windows, it may be advisable to bore one or more ½-inch holes through the **top** rail of the **storm** sash. For bedroom windows, a large opening which can be regulated may be desirable for additional ventilation.

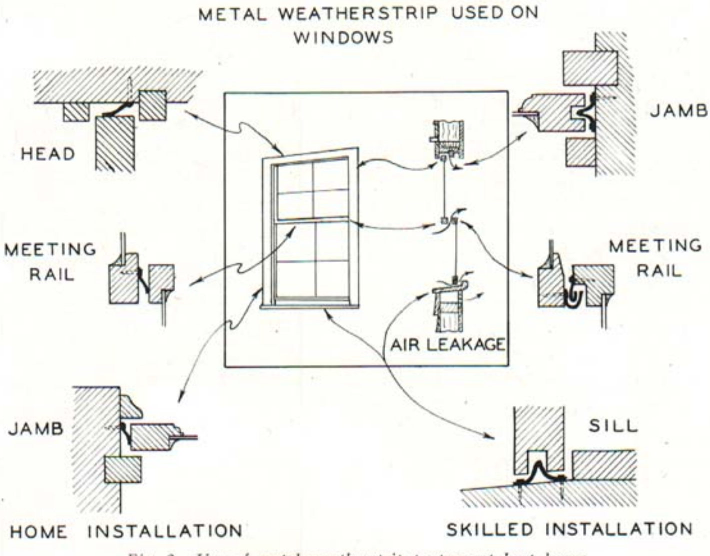


Fig. 2. Use of metal weatherstrip to prevent heat losses.

Weatherstripping of various types is available in strips which may be used to close the crack between the window sash and the frame. Fig. 2 shows some of these strips in place. Felt stripping is temporary and will have to be replaced frequently but is relatively inexpensive. Metal stripping is more permanent and should be applied carefully so that the windows open freely and the crack is effectively closed. It is usually desirable to have a skilled mechanic to install this type of weatherstripping.

Caulking compound, which is a plastic material similar to putty, may also be desirable to fill the crack between the window frame and masonry wall, The application of caulking compound is illustrated in Fig. 3.

Fig. 3. Using a caulking gun to fill cracks between window frame and masonry wall with caulking compound.

ATTIC INSULATION

The second logical step in weatherproofing an old house is to insulate the attic. If the attic floor is unfinished this is a very simple task. There are several forms of commercial insulation that may be placed between the floor joists to obtain practically any desired amount of insulation. Two convenient methods of insulating an unfinished attic are shown in Fig. 4 and on the cover page. Fig. 4 shows the installation of a 2-inch blanket, typical of the flexible type of insulation. These rolls are made in widths of 15 and 23 inches to fit snugly between framing members spaced either 16 or 24 inches on center.

(Photo: Wood Conversion Co., St. Paul, Minn.)

Fig. 4. Installing a flexible insulating blanket between floor joists in an unfinished attic.

If the attic floor is finished and the space is to be used for any purpose the insulating material can be applied between studs and rafters of the unfinished wall and roof. These surfaces can then be finished later in any desired manner. See Fig. 5.

Another method of insulating the unfinished walls and ceiling of an attic would be to apply board-form insulation directly over the studs and rafters. Board-form insulation may be obtained in many different patterns that will give the walls a finished appearance. If the walls are to be plastered, a board-form insulating lath may be used to which the plaster is applied directly. See Figs. 6 and 7.

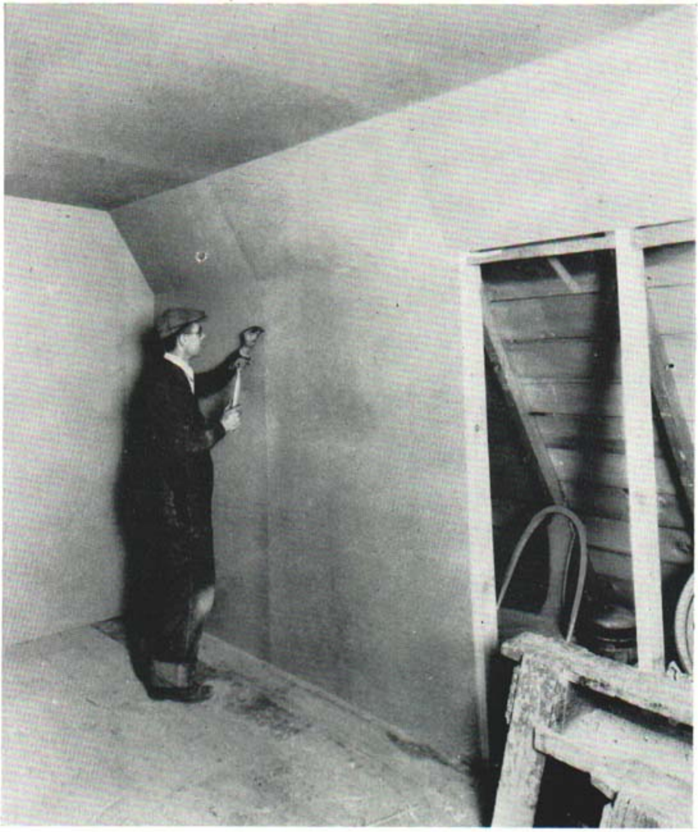
SIDE WALL INSULATION

In view of the above-mentioned savings which can be made at relatively small cost and frequently by using home labor, the practicability of attempting to gain greater fuel savings by insulating the side walls of old houses may be questioned owing to the complications involved.

If the exterior finish is in poor condition and needs to be repaired, the equivalent of about ⅓ inch of good insulation can be provided by applying new siding over the old. If the plaster needs to be replaced some type of board-form insulation can be applied directly over the old plaster. But if the interior and exterior finish are in good condition a more practical method of insulating the walls may be to fill the spaces between the studs with an insulating material. If these spaces are open from sill to plate they may be filled without too much trouble, but if there are braces or fire stops between the studs, it will be necessary to remove strips of siding at the plate and just below each obstruction to fill the spaces between them.

(Photo: Murphy Supply Co., Lansing, Mich.)

Fig. 5. Mineral wool batts are easily placed between framing members of a new house or in an unfinished attic. Note the strips holding the batts between ceiling joists and how completely the space between framing members is filled.



(Photo: Insulite, Minneapolis 2, Minn.)

Fig. 6. Four-foot sheets of rigid insulation applied to inside surface of wall studs and ceiling rafters.

CONDENSATION IN WALLS

In recent years difficulties resulting from condensation of moisture between the walls of insulated houses has received considerable attention. That such condensation will occur in tightly constructed houses when the room humidity is unusually high can be demonstrated by application of well known physical facts. When there is a great difference in temperature between the inside and outside surface of any wall, there will be considerable difference in water vapor pressure between the hot and the cold side and water vapor will actually be forced through the wall from the hot side to the cold side. If the air has a high humidity, it will reach a point somewhere between the hot and cold surface where condensation will occur. However, there is no evidence to support any claim that some insulating materials "draw" moisture. If conditions are favorable for condensation it will occur regardless of what insulating material is used.

In older houses, this condensation causes little trouble owing to the fact that there is ample circulation of air through cracks in the siding and sheathing through which moisture can escape to the outside. Attempts to reduce this circulation of air in newer houses perhaps has been carried to the extreme. If moisture accumulates in sufficient quantities because of tight exterior wall construction, it may seep through the plaster and stain the interior finish. It may also move to the outside and cause the paint to peal from the outside

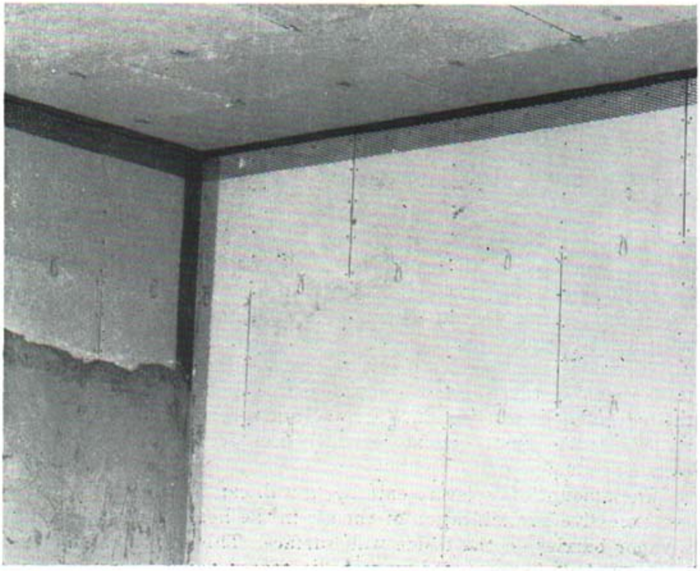


Fig. 7. A plaster base of 16 by 48-inch panels of rigid insulation. Note metal clips to reinforce plaster over insulation joints and expanded metal lath to reinforce plaster in all corners.

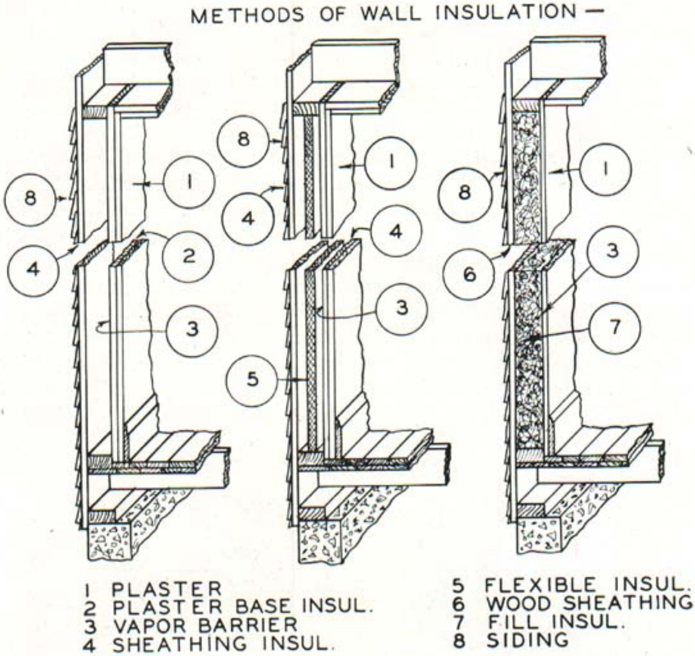


Fig. 8. Methods of wall insulation.

surface. Such paint failures have been observed on new houses where the walls have been made tight with insulation and on old houses where the relatively weather-tight side walls have recently been filled with insulation.

To reduce the troubles resulting from condensation, two precautions should be taken. First, some measures should be taken to retard the movement of moisture into the wall and second some means should be provided to let the moisture which does accumulate in the wall, escape gradually.

The amount of moisture entering a wall can be reduced by reducing excessive humidification of the air in the home and by providing a vapor barrier on the inside wall surface. This vapor barrier may be an asphalt impregnated or metallic coated paper over the inside surface of the studs or a metallic paint on the inside wall surface, or both, for maximum protection.

In spite of all precautions, some moisture will enter the wall which should be permitted to escape readily to the outside. To facilitate this escape, the outside wall covering should be less resistant to the passage of moisture than the inside covering. The wall sections in Fig. 8 show various methods of insulating walls of a residence to avoid troublesome accumulation of moisture within the insulated walls. However, if there is any question about the practicability of side wall insulation, a competent and experienced builder should be consulted.

Where insulation is placed between the joists, studs, or rafters of unfinished or loosely floored attics there is usually adequate circulation of air around it to eliminate any trouble from condensation. In this connection it is desirable to install louvers in each end of any attic to facilitate the removal of moisture in winter and of warm air in summer.

TYPE OF INSULATION TO USE

During the past few years, the ever increasing demand for insulation has resulted in the production of numerous new materials. Most of these materials can be grouped into three general classes:

(1) **Rigid or board-form** insulation is manufactured in panels which are usually 4 feet wide and in varying thickness from one-half inch to 2 inches and in lengths from 6 feet to 12 feet. This type of insulation has considerable structural strength and is used as sheathing, plaster base, or interior finish. When used as sheathing, these boards are sometimes coated or impregnated with asphalt or coated with a metallic reflecting surface.

(2) **Flexible type** insulation is made in rolls or batts to be tucked in between joists, studs, or rafters. It usually consists of loosely felted or fibrous materials covered on one or both sides with asphalt paper. It is made in various thicknesses from one-half inch to 4 inches. Some forms of felted insulation have some structural strength and the insulating value per inch of thickness is slightly greater than the board-form or rigid insulation.

(3) **Filltype** insulation is shredded or granulated material in bulk form that is used to fill the spaces in walls, floors, and roof construction. It has no structural strength but usually has greater insulating value per inch of thickness than other forms of insulation. The type of insulating material to use will depend upon the construction of the house to be insulated, where the insulation is to be used and the purpose for which it is intended. Where the greatest amount

of insulation for each dollar of investment is the main consideration a filltype insulation will be the logical one to use. A flexible or blanket type insulation used in the walls of a building permits more circulation of air through the wall space and will facilitate the removal of condensed moisture. Where some structural strength or a rigid surface is desirable, the board-form insulation would, of course, be used.

COST OF INSULATION

The cost of insulating a house is always an important factor but one that is difficult to analyze. The cost of insulating an old house is considerably different than the cost at the time of construction. The labor involved in insulating an old house would normally be greater and the type of material that could be used would be more limited.

Benefits from the use of insulation in increasing thicknesses follows the law of diminishing returns, and from a purely investment standpoint the returns on the first inch of insulation would be greater than on additional thicknesses. (See Fig. 9.) The curve in Fig. 9 shows the reduction in heat conductivity as increasing inches of insulation are added to a standard uninsulated ceiling as shown in Section No. 1, Fig. 10. This ceiling, uninsulated, has a heat loss of

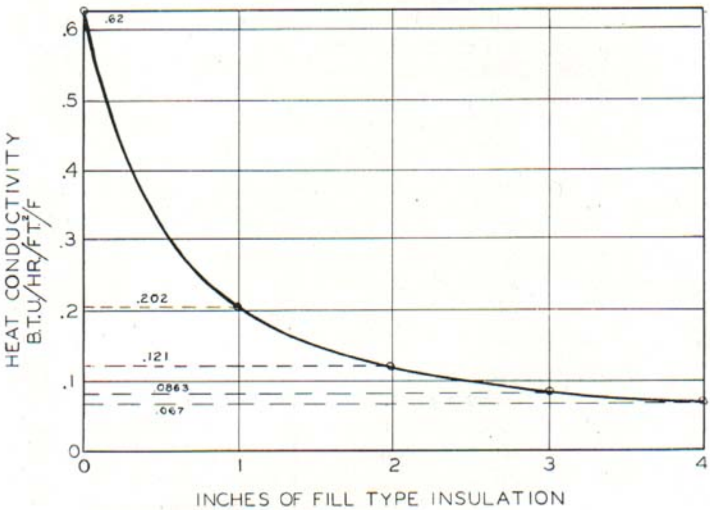


Fig. 9. Curve illustrating law of diminishing returns as applied to insulation.

INSULATION CHART CEILINGS, FLOORS AND ROOFS		
SECTION	DESCRIPTION	INSULATING VALUE
① U = .62 	Joists, wood lath, and plaster	1.62
② U = .29 	Sub-floor, joists, wood lath and plaster	3.45
③ U = .24 	Finished floor, sub-floor 6" joist space, wood lath and plaster	4.16
④ U = .12 	2" blanket insulation wood lath and plaster	8.3
⑤ U = .065 	4" fill insulation wood lath and plaster	15.4
⑥ U = .34 	Finished floor, sub-floor joists	2.94
⑦ U = .24 	Finished floor, sub-floor joists, 1" rigid insulation	4.16
⑧ U = .48 	Roof - wood shingles, slatted roof boards	2.08
⑨ U = .083 	Roof - wood shingles, slatted roof boards, 3" bat or blanket.	12.0
⑩ U = .53 	Roof - asphalt shingles, solid rock sheathing, rafters	1.89
⑪ U = .085 	Roof - asphalt shingles, solid roof sheathing, 3" bat or blanket insulation.	11.8
⑫ U = .11 	Roof - asphalt shingles, solid roof sheathing, 2" bat or blanket insulation.	9.1
Values from A.S.H.V.E. Guide		

Fig. 10. Insulation chart for ceilings, floors, and roofs.

.622 British Thermal Units every hour for each square foot of exposed area, and for each degree Fahrenheit difference between the hot and cold side. This is usually written .622 B.T.U./hr/sq. ft./F°.

It will be noted readily that the first inch of insulation reduced the heat loss through the ceiling from .622 B.T.U./hr/sq.ft./F° to .202 B.T.U./hr/sq.ft./F°. The second inch of insulation reduces the heat loss from .202 to .121 B.T.U./hr/sq.ft./F°. The reduction as the result of the first inch of insulation was .42 B.T.U./hr/sq.ft./F°. The reduction resulting from the second inch was only .081 B.T.U., and it becomes smaller with each additional inch of insulation, indicating a diminishing value as the amount of insulation becomes greater.

In general, each house will present individual problems and the type and amount of insulation to use perhaps can best be decided by the owner in consultation with an experienced builder. However, the insulation charts for various types of roof, floor and wall sections shown in Figs. 10, 11 and 12 should be a valuable guide in determining the thickness of insulation to use. These charts indicate resistance to the passage of heat by various length bars opposite each section. The longer bar, the better the insulation.

If the construction of any part of a house is known, it can be compared with a similar section on the chart and the relative insulating value determined. Then, by comparison with other sections having more insulation it should be possible to estimate the amount of insulation to be added to the known section.

The floor section No. 1 shown in Fig. 10 is typical of most attic floors found in existing houses in Michigan. This construction does not provide adequate insulation for optimum comfort and fuel saving during the long and severe winter weather often experienced in Michigan. During the hot and humid months of summer, it will not provide adequate protection from the heat of the sun and the rooms below will be uncomfortably warm.

Some additional insulation is desirable but the type and amount of insulating material to use will depend upon how the attic is to be used subsequently and how conveniently it can be reached for installation purposes.

To determine the maximum amount of insulation consistent with fuel economy, it will be necessary to compare the savings in fuel cost with the yearly cost of owning the insulation. This can best be shown by an example. The cost of applying insulation to an average six-room house may be $200. If 10 percent of this cost can be accepted as a fair charge for rental overhead, it will cost $20 each year to own

INSULATION CHART
WALL SECTIONS

SECTION	DESCRIPTION	INSULATING VALUE
① U=.715	Boards, paper, studs	1.4
② U=.323	Siding, studs and air space, wood lath and plaster	3.1
③ U=.244	Siding, paper, wood sheathing, studs, and air space, wood lath and plaster	4.1
④ U=.294	Same as wall No. 3 except asbestos or composition shingles used in place of siding	3.4
⑤ U=.244	Same as wall No. 3 except metal lath is used in place of wood lath	4.1
⑥ U=.159	Siding, paper, 1" rigid insulation studs and air space, wood lath and plaster	6.3
⑦ U=.066	Same as No. 3 with 4" mineral wool fill insulation	15.2
⑧ U=.084	Same as No. 3 with 4" dry shaving fill insulation	11.9
⑨ U=.192	Same as No. 2 except for addition of furring strips, paper and siding (or shingles) over old siding	5.2
⑩ U=.179	Same as No. 2 except for addition of furring strips, and ½" insulating board over old plaster	5.6
⑪ U=.123	Same as No. 3 with 4" stud space divided into two spaces with 1" flexible insulation	8.1

Values from A.S.H.V.E. Guide

Fig. 11. Insulation chart for wall sections.

this insulation. The savings in fuel may be as much as four tons per year, which at $10 per ton would be $40. The difference of $20 represents the actual net saving in fuel cost which may be credited to adequate insulation.

SUGGESTED READING

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*Wooley, Harold W.
Dec. 1940. Moisture Condensation in Building Walls. National Bureau of Standards, U. S. Department of Commerce. Report BMS 63. 10c.

*Phillips, Thomas D.
July 1940. Effect of Ceiling Insulation Upon Summer Comfort. National Bureau of Standards, U. S. Department of Commerce. Report BMS 52. 10c.

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May 1943. Experimental Dry-wall Construction with Fiber Insulating Board. National Bureau of Standards, U. S. Department of Commerce. Report BMS 97. 10c.

APPENDIX

The Use of Sawdust or Shavings for Farm House Insulation

The insulating value of sawdust or wood shavings has long been recognized. Many of the early buildings, particularly ice houses and fruit and vegetable storages, were insulated with one or the other of these materials.

Sawdust seems to have been most frequently used, but the results were often discouraging. The sawdust used was generally obtained from the sawing of "green," or unseasoned lumber or from piles that had been exposed to the weather for some time. Fresh sawdust from

*May be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for the price indicated. Stamps are not acceptable.

INSULATION CHART
MASONRY WALLS

SECTION	DESCRIPTION		INSULATING VALUE
① U = .70 	8" solid concrete - plain wall	+	1 43
② U = .56 	8" hollow concrete block plain wall	+	1.79
③ U = .38 	Same as No. 2 with block cores filled with granular or loose insulation	o	2 63
④ U = .26 	Same as No. 1, furred, ½" rigid insulation, ½" plaster	+	3.85
⑤ U = .24 	Same as No. 2, furred, ½" rigid insulation, ½" plaster	o	4.16
⑥ U = .20 	8" filled concrete block - furred, building board without plaster	o	5.0
⑦ U = .41 	8" hollow cinder block plaih wall	+	2.43
⑧ U = .20 	Same as No. 7 with block cores filled with granular or loose insulation	o	5.0
⑨ U = .20 	Same as No. 7, furred, ½ riggid insulation, ½" plaster	o	5.0
⑩ U = .15 	Same as No. 9 with block cores filled with granular or loose insulation	o	6.65
⑪ U = .22 	8" brick - with furring and building board - no plaster	+	4.55

o Values from Nat Concrete Masonry Assn. + Values from A.S.H.V.E. Guide

Fig. 12. Insulation chart for masonry walls.

green lumber is a very good medium for the development of wood-destroying organisms and in many cases, the sawdust used for insulation was partially decayed before it was used.

When placed in a building, often in the wall space between studs, decomposition continued, causing the sawdust to settle and making it necessary frequently to add more sawdust to keep the walls full. The walls in many of these old buildings were rather loosely constructed and the sawdust readily absorbed moisture. Even though dry sawdust had been used, it not only became subject to decay when wet but its insulating value decreased.

Wood shavings are more desirable for insulation than sawdust. They are usually obtained from dry lumber and therefore are more resistant to the attacks of fungi and cellulose—decomposing bacteria. They do not settle so readily as sawdust but remain loose and "fluffy" and therefore have greater insulating value than sawdust.

The recognized value of farm house insulation, a better knowledge of the use of insulating materials and the availability of wood shavings in many localities of Michigan has stimulated a new interest in the use of such materials. The advantages of dry wood shavings for insulation are:

1. Good insulating properties
2. Availability
3. Low cost

The disadvantages are:

1. Not recognized by building codes
2. No uniformity of material

Most of the objections frequently raised against the use of dry wood shavings and similar materials are not necessarily disadvantages but are obstacles of prejudice.

The use of shavings for insulation does not in itself constitute a fire hazard. Although shavings are inflammable and if ignited will burn along with all the other readily inflammable materials in a frame building, they may actually be a fire retardent. When used in the wall space, they destroy the flue action of these spaces and retard the spread of flames.

There is likewise no evidence to support the objection that these insulating materials would harbor insects and vermin any more than the same building without this type of insulation.

If placed between the walls of a building, wood shavings would be subject to the same moisture problems as discussed previously (see page 10, condensation in walls). Unless corrected, this condition might result in some deterioration from decay. If the same precautions are used as suggested for other insulating materials, no serious trouble should develop.

Bearing in mind the relative importance of side wall insulation, it may not be necessary to put sawdust or shavings between the studs if the attic is properly insulated. Sawdust or shavings placed between floor joists in an unfinished attic would be kept dry by ample air circulation through the attic and would keep indefinitely in good condition.

If sawdust or shavings are dry when used and kept dry thereafter, no particular treatment seems to be necessary for fire-proofing, vermin-proofing, or moisture-proofing. Those interested in additional information on such treatments for sawdust and shavings to be used for insulation are referred to the following sources:

1. Forest Products Laboratory of U. S. Forest Service, Madison, Wisconsin.

2. Forest Products Laboratories of Canada, Ottawa, Canada.

Sawdust, wood shavings, and other similar types of native materials are not suggested as a substitute for commercial insulation in all cases, but where they are available, they offer an economical solution to the problem of insulating many types of farm buildings.