

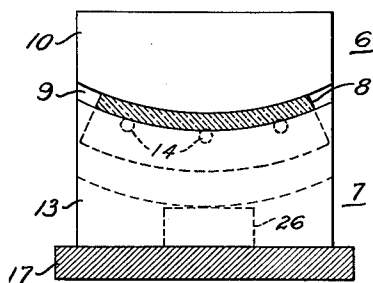
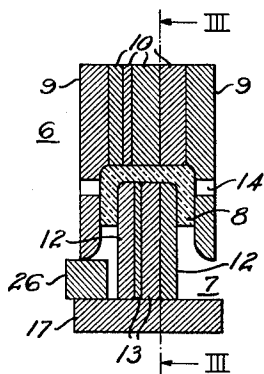
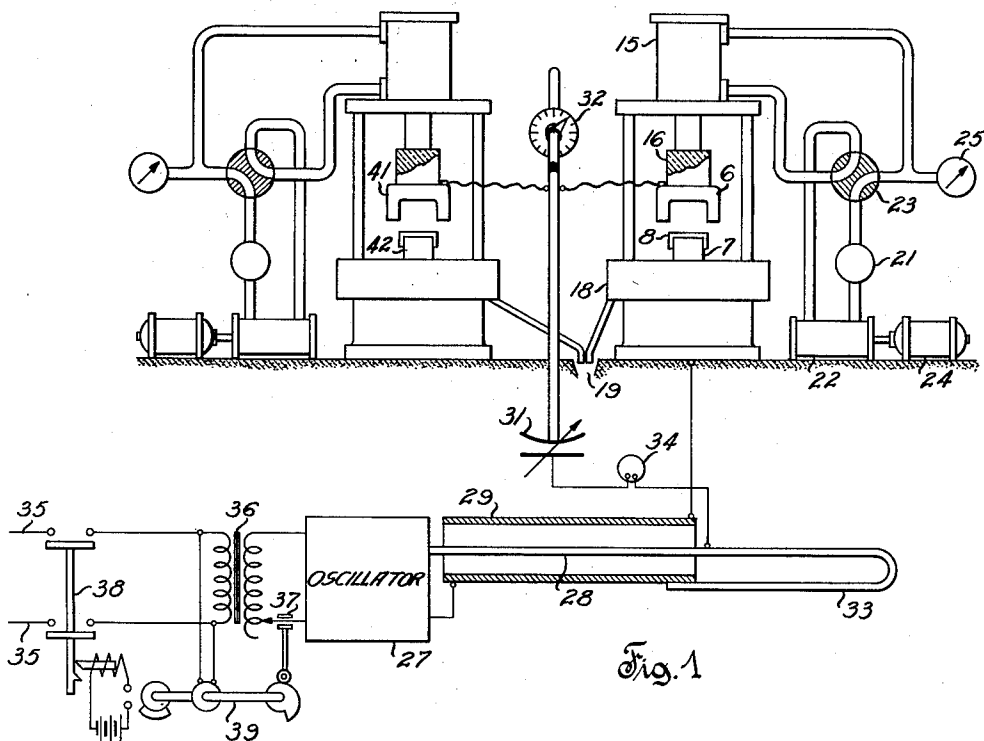
May 6, 1952

L. C. AICHER

2,595,501

METHOD OF MOLDING INSULATING MATERIAL

Filed July 27, 1946



INVENTOR
Louis E. Aicher
 BY *André J. Jumeaux*
 ATTORNEY

UNITED STATES PATENT OFFICE

2,595,501

METHOD OF MOLDING INSULATING MATERIAL

Louis C. Aicher, Wauwatosa, Wis., assignor to
Allis-Chalmers Manufacturing Company, Mil-
waukee, Wis., a corporation of Delaware

Application July 27, 1946, Serial No. 686,742

6 Claims. (Cl. 154—2.6)

1

This invention relates in general to improve-
ments in methods of molding insulating material
and more particularly to a method of forming
articles of cellulosic material having a substan-
tially uniform wall thickness.

The manufacture of electrical apparatus such
as transformers and dynamoelectric machines
requires the use of elements of insulating ma-
terial which have a substantially uniform wall
thickness and are adapted to be made by deform-
ing raw material in sheet form. Where insula-
tion is protected against moisture the raw ma-
terial may be a laminated cellulosic material such
as fullerboard. To make insulating elements in
which the raw material is to be considerably de-
formed from the flat sheet form the fullerboard,
or other raw material, may first be soaked in a
suitable vaporizable softening liquid such as
water or alcohol to render it more pliable. The
wet material is then pressed between heated dies
to cause it to assume the desired shape and to
expel the water or other liquid absorbed during
the soaking operation. Heat transmission how-
ever takes place slowly through fullerboard and
the dies therefore may only be heated to a rela-
tively low temperature to avoid overheating of
the superficial portions of the article being made,
so that the drying process requires an excessive
length of time.

If an alternating electric field of suitable in-
tensity and frequency is established between the
dies, the wet fullerboard may become heated
throughout to a relatively uniform temperature
by the production of dielectric losses therein, so
that the heating rate may be accelerated to a
considerable extent without locally overheating
the material. The dies nevertheless should be
brought to substantially the temperature of ebul-
lition of the softening liquid, which will be as-
sumed hereinafter to be water, so as not to chill
the superficial portions of the material. To elim-
inate the necessity of separate preheating means
for the dies it is advantageous to preheat the dies
by applying an alternating electric field to a pre-
viously molded article or to a body of other dry
insulating material inserted between the dies.

As the dies and the material contained there-
between constitute a variable capacitive load for
the oscillator, it is advantageous to connect an
adjustable capacitor in series therewith to per-
mit tuning the circuit of the dies to resonance for
the frequency of the voltage of the oscillator. If
necessary, an inductive conductor may be con-
nected across the dies and the capacitor to assist
the capacitor in bringing the circuit into res-

2

onance. After the article being made reaches the
temperature of ebullition of water the voltage
impressed on the dies may be reduced to prevent
production of steam under excessive pressure
within the article. It is possible to mold several
articles simultaneously in dies connected in paral-
lel in the circuit because the production of heat
within each article slows up in the course of its
drying, so that the moisture content tends to
reach the desired value simultaneously in the dif-
ferent articles.

It is therefore an object of the present inven-
tion to provide an improved method of mold-
ing an article of insulating material from a sheet
of laminated cellulosic insulating material re-
quiring molding in the wet stage.

Another object of the present invention is to
provide an improved method of molding an
article of insulating material in which the article
is held to the desired shape while moisture is be-
ing expelled therefrom.

Another object of the present invention is to
provide an improved method of simultaneously
molding a plurality of articles of insulating ma-
terial from wet stock in which the drying of the
different articles tends to proceed at a uniform
rate.

Objects and advantages other than those above
set forth will be apparent from the following de-
scription when read in connection with the ac-
companying drawing in which:

Fig. 1 diagrammatically illustrates a system
comprising two hydraulic presses and source of
alternating current for simultaneously molding
two articles of insulating material from wet sheet
stock by dielectric heating;

Fig. 2 is an enlarged view in cross section
through a pair of dies shown installed in a press
in Fig. 1; and

Fig. 3 is a view in cross section through the dies
taken along line III—III in Fig. 2.

Referring more particularly to the drawing by
characters of reference, numerals 6 and 7 desig-
nate a pair of dies for molding articles from lam-
inated cellulosic insulating material such as ful-
lerboard. Dies 6, 7 may have any suitable size and
shape depending on the size and shape of the
articles to be made, and it will be assumed that
the dies are adapted to mold a piece of curved
insulating channel 8. The dies are made at least
partly of a suitable conductive material, and the
conductive portions thereof may either be in con-
tact with the material to be molded or may be
embedded in the insulating material. Satisfac-

tory results have been consistently obtained with dies made of steel.

To reduce the cost of the dies required for molding sets of channels having the same curvature but different widths or thicknesses, die 6 may be built up of end plates 9 machined to provide the desired radius at the juncture of the web with the flanges of the channel, and of spacer plates 10 of different thicknesses of which a suitable number may be stacked between the end plates to match the desired outer profile of the channel. Die 7 may likewise be built up of end plates 12 and spacer plates 13 to match the desired inner profile of the channel. The portions of the dies which are not in contact with channel 8 are so shaped as to permit impression of a substantial voltage therebetween without flash-over and as to provide a path for the escape of steam from the channel. Ports 14 may also be provided in the dies to relieve excessive steam pressures which may build up within the channels.

Dies 6, 7 may be supported and relatively displaced by any suitable means such as a hydraulic press 15. One of the dies, die 6 for example, is mounted on press 15 through a block of suitable insulating material 16 such as Bakelite. The different component parts of die 7 may be mounted on a stand 17 resting in a tray 18 for collecting water expelled from channel 8 and discharging the collected water into a drain 19. The ram of press 15 may be actuated by means of suitable liquid supplied thereto from a reservoir 21 through a pump 22 and a four-way valve 23. Pump 22 may be driven by any suitable means such as an electric motor 24. The pressure exerted on the ram on at least the down-stroke may preferably be ascertained by means of a pressure gauge 25. A gauge block 26 may be provided for ascertaining the spacing between the dies and, if desired, for serving as a stop to limit the travel of die 6.

A voltage of suitable magnitude and frequency may be impressed between dies 6, 7 from any suitable known oscillator, generally designated 27. The major portion of the connections between the dies and the oscillator preferably consists of coaxial conductors 28, 29 of relatively low impedance. The portion of the load circuit of oscillator 27, consisting of dies 6, 7 and the connections between the dies and the coaxial conductors, is preferably arranged to be resonant at the frequency impressed thereon and to radiate electromagnetic waves to the lowest possible extent. The resonant condition of the circuit may be established by means of a variable capacitor 31 connected between conductor 28 and die 6 or otherwise inserted in series in the circuit. A dial 32 associated with a pointer mounted on the shaft of the movable plate of capacitor 31 permits setting the plate in any preselected position. If necessary, an inductive conductor 33 forming a loop, may be connected between conductors 28, 29 to produce a coarse tuning of the circuit, fine tuning then being effected by adjustment of capacitor 31. The tuned condition of the circuit may be ascertained by means of an ammeter in the plate circuit of the oscillator or by means of an ammeter 34 connected in series with the dies.

Oscillator 27 may be supplied from any suitable current supply such as a circuit 35 energized from a suitable alternating current generator (not shown). The oscillator proper or the connections of circuit 35 therewith may include any suitable known voltage regulating means such as

a transformer 36 provided with a tap changer 37. The connections between transformer 36 and circuit 35 may be interrupted by means of a switch 38. Operation of tap changer 37 and of switch 38 may be controlled manually or by means of a timer, generally designated 39. If the output of oscillator 27 is sufficiently large, dies 6, 7 may be connected in parallel with one or more additional pairs of dies such as dies 41, 42, to permit simultaneous molding of a plurality of articles.

In operation, assuming that an article is to be molded in dies 6, 7, the dies are preferably first heated to substantially the boiling point of water. Such heating is conveniently effected by inserting between the dies a previously molded dry channel or dry strips of fullerboard, closing the dies, and closing switch 38 to cause oscillator to impress an alternating voltage on the dies. If the output voltage of oscillator 27 has a value of the order of several thousand volts and a frequency of the order of two to thirty megacycles per second, the insulating material inserted between dies 6, 7 gradually heats up by production therein of dielectric losses. The heat generated in the material is transmitted to dies 6, 7 by conduction, and the operation is continued until the dies have reached the desired temperature. While the dies are thus being heated or while a channel is already in process of being molded in the dies, a sheet of fullerboard of suitable size and thickness is placed to soak in a tray of water. The sheet absorbs a considerable amount of water and increases in volume while becoming more pliable. The sheet may further be kneaded by hand to loosen the bond between the plies thereof and thereby facilitate subsequent deformation of the sheet within the dies.

Switch 38 is opened and the heated dies are separated, and the material previously confined therebetween is removed. The dies are then preferably coated with a film of liquid lubricating material insoluble in water to prevent sticking of the fullerboard therein and to reduce corrosion of the dies. Such liquid film may be obtained by spraying the dies with a liquid hydrocarbon or by rubbing the dies with a cake of paraffin, which melts at a temperature well below the boiling point of water.

The softened sheet of fullerboard is then laid on die 7, preferably with the fibers of the fullerboard directed across the die to reduce the danger of tearing the sheet when the dies are closed. The sheet is shaped by hand over die 7, the loosened structure of the sheet enabling the plies thereof to yield and to slide relatively to each other so as to permit the sheet to be applied to die 7 substantially without wrinkles.

Valve 23 is then actuated to cause the ram of press 15 to force die 6 on die 7. The sheet of fullerboard is thus compressed between the dies and a large portion of the water absorbed by the sheet is thus expelled, collected in tray 18 and discharged to drain 19. The sheet, being confined between the dies, is thereby molded to the desired shape. Valve 23 may be so actuated as to admit fluid from pump 22 to the upper cylinder of press 15 until gauge 25 registers a predetermined pressure which has previously been found adequate for compressing the web of channel 8 to the desired thickness.

The ram may also be caused to drop until die 6 abuts a gauge block or stop 26 resting on base 17. If block 26 is of insulating material the block may be left in place during the dielectric heating operation. If block 26 is made of metal it must

be removed before application of voltage to dies 6, 7. For the latter purpose it may be convenient to observe the pressure indicated by gauge 25 at the moment of engagement of die 6 with block 26, release the pressure slightly by movement of valve 23 to permit die 6 to rise, remove block 26 and bring the pressure to the previously observed value to return die 6 to the position at which it engaged block 26.

Switch 38 may then be reclosed to cause oscillator 27 to impress an alternating voltage on the dies. Capacitor 31 is adjusted to the value rendering the die circuit resonant, and tap changer 37 or other voltage regulating device is adjusted manually or by means of timer 39 to cause impression on the die of a relatively high voltage to raise the temperature of channel 8 to the boiling point of water at the highest possible rate. When channel 8 reaches the boiling point of water, the remainder of the water absorbed thereby during the soaking operation gradually escapes between the dies in the form of steam. The water content of channel 8 thus gradually decreases, whereby the capacity introduced by channel 8 in the output circuit of oscillator 27 gradually decreases. Capacitor 31 therefore should be readjusted at frequent intervals during the heating process to maintain the balance between the inductance and capacitance of the die circuit.

As channel 8 is confined between dies 6, 7 over the greatest portion of its surface, the escape of steam therefrom can take place only over a relatively small area. The rate of vaporization of the water contained in channel 8 should therefore be regulated to prevent building up of excessive pressures within the channel. Such regulation may be effected by actuation of tap changer 37 either manually or by timer 39 in accordance with a previously determined schedule.

The heating operation may be terminated when the water absorbed by the fullerboard during the soaking operation has been substantially entirely expelled and the moisture content of channel 8 has returned to substantially the normal value for dry fullerboard, which is in the neighborhood of six per cent at room temperature. Channels of a uniform size require a substantially uniform heating time, and opening of switch 38 to terminate the heating operation may therefore be effected by timer 39. Switch 38 may also be opened when return of channel 8 to the dry state is evidenced by the particular adjustment of capacitor 31 required for bringing the circuit of the dies back to the tuned condition.

Valve 23 may then be actuated to cause the ram of press 15 to separate dies 6, 7 and channel 8 may be removed from the dies. Another sheet of wet fullerboard may then be inserted in the dies for forming another channel in the manner above set forth. It will be understood however that the different steps of the process may be performed either in the exact sequence indicated above or in any other order that may be found convenient or advantageous.

When two or more pairs of dies such as dies 6, 7 and 41, 42 are connected in parallel, the dies are preferably heated simultaneously in the manner above set forth. The heated dies are then charged with wet sheets of fullerboard and reclosed. The different dies have the electrical properties of a plurality of parallel capacitors and the die circuit may again be tuned by adjustment of the variable capacitor common thereto. During the drying operation, the rate of heat produc-

tion in each channel gradually decreases to an extent determined by the decrease in the water content of the channel. The channel which has the higher water content therefore heats faster than the channel having the lower water content. The heating rate of the different channels thus adjusts itself automatically in such manner that the different channels heat at substantially the same rate and that the moisture content of the channels reaches the desired value substantially simultaneously in different channels.

Although but one embodiment of the present invention has been illustrated and described, it is apparent to one skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims. Features disclosed but not claimed herein are claimed in a copending application Serial No. 687,738 of Louis C. Aicher and Fred J. Vogel, filed August 1, 1946.

It is claimed and desired to secure by Letters Patent:

1. A method of molding an article of insulating material comprising the steps of closing a pair of conductive dies on a piece of dry insulating material shaped to fit between said dies, connecting said dies to a source of high frequency electric current to cause heating of said piece of insulating material and of said dies to substantially the temperature of ebullition of a softening liquid, soaking a sheet of laminated cellulosic insulating material in said softening liquid, disconnecting said dies from said source, substituting said sheets for said piece, pressing said sheet between said dies, and reconnecting said dies with said source to vaporize the liquid absorbed by said sheet.

2. A method of molding an article of insulating material comprising the steps of closing a pair of conductive dies on a piece of insulating material shaped to fit between said dies, connecting said dies to a source of high frequency electric current to cause heating of said piece of insulating material by production of dielectric losses therein and conduction of heat from said piece of insulating material to said dies to raise said dies to substantially the temperature of ebullition of a softening liquid, disconnecting said dies from said source, separating said dies and removing said piece therefrom, rubbing said dies with a cake of paraffin to form a liquid lubricating film thereon, soaking a sheet of laminated cellulosic insulating material in said softening liquid, kneading said sheet to loosen the bond between the plies thereof, shaping said sheet on one of said dies, pressing said sheet between said dies to expel a portion of the softening liquid absorbed by said sheet and mold said sheet to the desired shape, and reconnecting said dies to said source to dry said sheet and restore the bond between plies thereof.

3. A method of molding an article of insulating material comprising the steps of soaking a sheet of laminated cellulosic insulating material in a softening liquid, placing said sheet on one of a pair of conductive dies while said dies are held in open position, causing plies of said sheet to yield and slide relatively to each other to thereby shape said sheet to conform to the said one die, closing said dies to press said sheet between said dies, and connecting said dies to a source of high frequency electric current to vaporize the liquid absorbed by said sheet.

4. A method of molding an article of insulating

7

material comprising the steps of soaking a sheet of laminated cellulosic material in a softening liquid, kneading said sheet to loosen the bond between the plies thereof, placing said sheet on one of a pair of conductive dies while said dies are held in open position, causing plies of said sheet to yield and slide relatively to each other to thereby shape said sheet to conform to the said one die, closing said dies to press said sheet between said dies to expel a portion of the liquid absorbed by said sheet and to perfect the molding of said sheet to the desired shape, and connecting said dies to a source of high frequency electric current to dry said sheet and restore the bond between plies thereof.

5. A method of molding an article of insulating material comprising the steps of soaking a sheet of laminated cellulosic insulating material in a softening liquid, placing said sheet on one of a pair of conductive dies while said dies are held in open position, causing plies of said sheet to yield and slide relatively to each other to thereby shape said sheet to conform to the said one die, closing said dies to press said sheet between said dies under a predetermined pressure to perfect the molding of said sheet to the desired shape and to expel a portion of the liquid absorbed by said sheet, and connecting said dies to a source of high frequency electric current to vaporize the remainder of the liquid absorbed by said sheet.

6. A method of molding an article of insulating material comprising the steps of soaking a sheet

8

of laminated cellulosic insulating material in a softening liquid, placing said sheet on one of a pair of conductive dies while said dies are held in open position, causing plies of said sheet to yield and slide relatively to each other to thereby shape said sheet to conform to the said one die, closing said dies to a predetermined spacing to expel a portion of the water absorbed by said sheet and to perfect the molding of said sheet to predetermined dimensions, and connecting said dies to a source of high frequency electric current to vaporize the remainder of the liquid absorbed by said sheet.

LOUIS C. AICHER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,471,906	Longren	Oct. 23, 1923
1,904,268	Bronson	Apr. 18, 1933
2,089,966	Kassner	Aug. 17, 1937
2,112,418	Hart, Jr., et al.	Mar. 29, 1938
2,179,261	Keller	Nov. 7, 1939
2,267,817	Costa	Dec. 30, 1941
2,325,637	Stewart	Aug. 13, 1943
2,338,685	Dee	Jan. 4, 1944
2,388,824	Brown	Nov. 13, 1945
2,398,326	Reeves	Apr. 9, 1946
2,449,451	Cassen	Sept. 14, 1948