

BOLIGOPVARMNINGSUDVALGETS MEDDELELSE NR. 1A og 1B

1 A

BOLIGOPVARMNINGSUDVALGETS  
FORHISTORIE

AF

AUGUST KROGH

1 B

EN KORTFATTET OVERSIGT  
OVER BOLIGOPVARMNINGSUDVALGETS  
VIRKSOMHED 1938-45

AF

OTTO JUEL JØRGENSEN

KØBENHAVN

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1948

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LABORATORIET FOR VARMEISOLERING  
DANMARKS TEKNISKE HØJSKOLE  
HJORTEKÆRSVEJ 99, LYNGBY. TLF. 87 88 60

*nr. 101*

*0-0*

*Boligopvarmningsudvalgets Medlemmer*  
*Members of the committee for the study of domestic heating.*

Professor, dr. phil. August Krogh (formand),  
Afdelingsingeniør Otto Juel Jørgensen (sekretær),  
Professor F. C. Becker,  
Overingeniør Carl Bruun,  
Læge Sven Christiansen,  
Civilingeniør J. Falck,  
Direktør, Civilingeniør Gunnar Gregersen,  
Vicedirektør, Civilingeniør P. Hempel,  
Overlæge, Dr. phil. O. M. Henriques,  
Professor E. S. Johansen,  
Arkitekt Mogens Koch,  
Civilingeniør A. von der Lieth,  
Professor J. L. Mansa,  
Direktør Niels Pedersen,  
Overingeniør Carl U. Simonsen.

CONTRIBUTION NUMBER 1 A and 1 B from  
THE COMMITTEE FOR THE STUDY OF DOMESTIC HEATING,  
COPENHAGEN

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1 A

THE HISTORY AND SETTING UP  
OF THE COMMITTEE

BY

AUGUST KROGH

1 B

A SHORT SUMMARY  
OF THE WORK CARRIED OUT BY  
THE COMMITTEE IN THE YEARS  
1938—45

BY

OTTO JUEL JØRGENSEN

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COPENHAGEN

1948

## Forord

Boligopvarmningsudvalget udsender hermed en række forsøgsberetninger om sine arbejder og ønsker ved denne anledning at give nogle meddelelser om udvalgets forhistorie og nedsættelse, hvilket hermed sker i efterfølgende beretning nr. 1 A samt en kort oversigt over udvalgets arbejder i de forløbne aar, jvf. beretning 1 B.

Udvalgets medlemmer er:

Professor, dr. phil. August Krogh (formand),  
Afdelingsingeniør Otto Juel Jørgensen (sekretær),  
Professor F. C. Becker,  
Overingeniør Carl Bruun, for Fællesrepræsentationen for  
Dansk Haandværk og Industri,  
Læge Sven Christiansen,  
Civilingeniør J. Falck, for Kakkelovnsindustrien,  
Direktør, civilingeniør Gunnar Gregersen,  
Vicedirektør, civilingeniør P. Hempel,  
Overlæge, dr. phil. O. M. Henriques,  
Professor E. S. Johansen,  
Arkitekt Mogens Koch, for Akademisk Arkitektforening,  
Civilingeniør A. von der Lieth, for Industriraadet,  
Professor J. L. Mansa,  
Direktør Niels Pedersen, for Kreditforeningernes Staaende  
Fællesudvalg,  
Overingeniør Carl U. Simonsen, for Dansk Ingeniørforening.  
Udvalget udsender nedennævnte beretninger:

Nr. 1 A. Professor, dr. phil. August Krogh:

BOLIGOPVARMNINGSUDVALGETS FORHISTORIE.

Nr. 1 B. Afdelingsingeniør Otto Juel Jørgensen:

EN KORTFATTET OVERSIGT OVER BOLIGOPVARMNINGSUDVALGETS VIRKSOMHED 1938—45.

- Nr. 2.* Civilingeniør Lorents Pedersen:  
VARMETEKNISKE UNDERSØGELSER I ET FORSØGS-  
RUM.
- Nr. 3.* Dr. phil. Marius Nielsen:  
UNDERSØGELSER OVER RELATIONEN MELLEM BE-  
HAGELIGHEDSFORNEMMELSER, OPVARMNINGS-  
TILSTAND OG FYSIOLOGISKE REAKTIONER VED  
STILLESIDDENDE ARBEJDE.
- Nr. 4.* Dr. phil. Marius Nielsen:  
UNDERSØGELSER OVER BETYDNINGEN AF GULV-  
OPVARMNING FOR BEHAGELIGHEDSFORNEMMEL-  
SER OG FODTEMPERATURER.
- Nr. 5.* Professor, dr. phil. August Krogh:  
EN MIKROKLIMATOGRAF.
- Nr. 6.* Professor, dr. phil. August Krogh:  
MAALING AF TEXTILERS VARMEISOLERENDE  
EGENSKABER.
- Nr. 7.* Dr. phil. Marius Nielsen:  
UNDERSØGELSER OVER HUDENS VARMEUD-  
STRAALINGSEVNE.
- Nr. 8.* Overingeniør Carl Bruun:  
UNDERSØGELSER UDFØRT I PRAKSIS VEDRØRENDE  
REFLEKSVARMEANLÆG.
- Nr. 9.* Dr. med. Ove Bøje, dr. phil. Marius Nielsen og læge  
John Olesen:  
UNDERSØGELSER OVER BETYDNINGEN AF  
ENSIDIG STRAALINGSAFKØLING.
- Nr. 10.* Civilingeniør Lorents Pedersen:  
VARMEAFGIVELSE VED STRAALING OG KONVEK-  
TION FRA ET PAAKLÆDT MENNESKE.
- Nr. 11.* Civilingeniør Lorents Pedersen:  
TEMPERATURMAALINGER I FORSKELLIGE BOLIG-  
TYPER.
- Nr. 12.* Overingeniør Carl Bruun:  
SAMMENLIGNENDE MAALINGER OG BEREGNING-  
GER AF VARMEFORBRUG.

Jeg bringer herved en tak til de institutioner, Akademiet for de tekniske Videnskaber og Teknologisk Institut, som nedsatte og senere paa mange maader støttede udvalget og saaledes muliggjorde, at dette arbejde kunde paabegyndes og gennemføres. Ligeledes bringer jeg en tak til Statens Bygningsdirektorat og til de 3 fonds: Laurits Andersens Fond, Otto Mønstedts Fond og Thomas B. Thriges Fond, som gennem tilskud paa ialt ca. 230.000 Kr. har financieret udvalgets arbejde, samt til Kraks Legat, som ved tilskud til Teknologisk Institut paa 22,500 Kr. har muliggjort opførelsen af det forsøgsrum, som udvalget har benyttet. Sidst, men ikke mindst, takker jeg varmt alle udvalgets medlemmer og ganske særlig forsøgsudvalgets medlemmer, som har gjort en stor indsats til løsning af den fælles opgave, forsøgsledere og disses medhjælpere, der hver for sig har ydet sit bidrag til at trække det store og ofte tunge læs under forsøgsarbejdet, det administrative arbejde og under de mange saglige diskussioner om de fysiologiske og tekniske problemer, der saa nøje er kædet sammen.

En række resultater er naaet, som udvalget hermed fremlægger for offentligheden, og vi haaber, at Danmark hermed har ydet et bidrag til løsning af de opgaver, som man ogsaa arbejder paa andre steder. Mange problemer er endnu uafklaret, men forhåbentlig vil man blive sat i stand til at fortsætte det saaledes paabegyndte arbejde videre fremover.

*August Krogh.*

## BERETNING I A

### Udvalgets forhistorie og nedsættelse

meddelt af

Professor dr. phil. *August Krogh*.

Paa den internationale varmekongres i Wiesbaden i 1927\*) henledte overingeniør Carl U. Simonsen i et diskussionsindlæg opmærksomheden paa, hvorledes varmeafgivelsen fra det menneskelige legeme varierer med et værelses lufttemperatur og i særdeleshed med væggenes indvendige overfladetemperaturer; idet Simonsen forudsaa, at der maatte gøres et arbejde paa dette omraade, slog han til lyd for et samarbejde mellem varmeteknikere, arkitekter, offentligheden og kreditinstitutioner.

Det er rimeligt i dag, hvor boligopvarmningsudvalgets beretninger om de første arbejder foreligger, at minde om, at Simonsen allerede i 1927 har foretaget en problemstilling og indset nødvendigheden af, at opgaverne blev taget op til løsning.

I sin egenskab af leder af Teknologisk Instituts varmetekniske afdeling havde afdelingsingeniør O. Juel Jørgensen fra 1926 etableret et varmeteknisk laboratorium, som med særligt henblik paa spørgsmaalet varmeisolering af boliger blev indrettet til at foretage undersøgelser af materialers varmeledningsevne og andre nødvendige varmetekniske maalinge. I denne forbindelse skal det anføres, at afdelingen ikke alene interesserede sig for den teknisk-økonomiske side af sagen, men paa et tidligt tidspunkt søgte at knytte forbindelse med fysiologisk og medicinsk sagskundskab; saaledes blev et værdifuldt samarbejde først etableret med læge John Olesen og senere — i 1935 — arrangerede afdelingen en uofficiel og fordomsfri drøftelse mellem en del læger og ingeniører om boligopvarmningsens fysiologiske og tekniske problemer.

Jævnside hermed disponerede afdelingen i 1935—39 over en

\*) Se: Kongres für Heizung und Lüftung 8.—11. Sept. 1927, Bericht II, S. 52—57.



forsøgslejlighed i Østbanegade i København, hvor man foretog forskellige orienterende undersøgelser, som forberedelse til senere opgaver.

Med henblik paa kommende undersøgelser havde afdelingsingeniør Otto Juel Jørgensen i 1936 konstrueret og ladet fremstille en termostat, der havde samme form og størrelse som et menneskeligt legeme. Termostaten var fremstillet af tynd kobberplade, og i dens indre var anbragt elektriske varmelegemer, saaledes at termostaten kunde opvarmes, og dens overfladetemperatur reguleres automatisk paa et ønsket niveau; ved opvarmning til samme temperatur som et menneskeligt legeme, kunde den anvendes til at indicere et rums opvarmningstilstand. I løbet af foråret 1937 var den indreguleret og justeret og blev anvendt ved de ovennævnte malinger i forsøgslejligheden. Denne termostat er anvendt ved en række af udvalgets forsøg, saaledes som omtalt i beretningerne nr. 2, 3 og 10.

Endvidere skal det anføres, at overingeniør Carl Bruun tog initiativet til og gennemførte en række grundlæggende undersøgelser over forskellige former for straalevarme, saavel i praksis som i laboratorium, undersøgelser, der har sat sig spor i udvalgets arbejde.

Uafhængig af de ovennævnte forberedende arbejder havde lederen af Finseninstitutets laboratorium, overlæge, dr. phil. O. M. Henriques, udført en forsøgsrække vedrørende varmestraaling fra den menneskelige organisme. Idet Teknologisk Instituts varmetekniske afdeling arbejdede hen til at faa spørgsmaalet boligopvarmning taget op til grundig undersøgelse i samarbejde med læger, førte en gensidig orientering om de nævnte arbejder til, at der i 1937—38 blev ført nogle forhandlinger mellem Teknologisk Institut og Finseninstitutet om etablering af et samarbejde vedrørende herhenhørende undersøgelser. I samme tidsrum blev der afholdt foredrag af d'herrer Henriques, Juel Jørgensen og Simonsen i Dansk Ingeniørforening og Medicinsk Selskab om emnet — hvilket tydede paa en levende interesse for spørgsmaalet blandt fagfolk.

De saaledes udførte forberedende arbejder og forhandlinger førte til, at Teknologisk Instituts varmetekniske afdeling i Februar og Juni 1938 ansøgte Laurits Andersens Fond og Kraks Legat om tilskud paa henholdsvis 30.000 og 22.500 kr. til iværksættelse af forsøg vedrørende boligopvarmning. I disse ansøgninger hedder det bl. a.:

„... Af ovenstaaende kortfattede Bemærkninger vil det fremgaa, at man, saafremt man vil undersøge Problemet Boligopvarmning, ikke alene kan indskrænke sig til at undersøge forskellige Opvarmningssystemer og disses Funktion, men ogsaa maa inddrage Boligens Udformning i fysiologisk-varmeteknisk Henseende under saadanne Forsøg“.

Endvidere: „... og da de (fysiologiske Spørgsmaal) langt fra er afklaret, maa disse sidstnævnte Problemer underkastes en nærmere Undersøgelse jævnsides med Undersøgelser af de tekniske Spørgsmaal. Naar de fysiologiske og hygiejniske Forhold inddrages i en Undersøgelse, er det nødvendigt, at Forsøgsarbejdet foregaar i Samarbejde med Læger, ..., idet Lægerne maa søge at formulere de Krav, man af fysiologiske og hygiejniske Grunde maa stille til Boliger og Varmeanlæg ...“

Sluttelig: „Det kan derfor slaas fast, at det ved Gennemførelsen af Forsøg vil være paakrævet, at et nøje Samarbejde mellem Læger og Varmeteknikere muliggøres“.

Ved Teknologisk Instituts aarsfest i Maj 1938 holdt afdelingsingeniør Otto Juel Jørgensen et foredrag om boligopvarmning. Gennem foredraget blev der slaaet til lyd for, at undersøgelser vedrørende boligopvarmning burde tages op til behandling i samarbejde mellem fysiologisk-lægelig og varmeteknisk sagskundskab, idet foredraget ganske var paa linie med de nævnte ansøgninger.

Ansøgningen til Kraks Legat blev bevilget til Teknologisk Institut, hvorimod ansøgningen til Laurits Andersens Fond førte til, at fondets formand, professor P. O. Pedersen, henvendte sig til direktør Gunnar Gregersen og meddelte, at fondet var sindet at bevilge det ansøgte beløb, men paa den betingelse, at forsøgene blev ledet af et udvalg, nedsat af Akademiet for de tekniske Videnskaber.

Efter forhandlinger ført imellem direktør Gunnar Gregersen og professor P. O. Pedersen enedes man om, at Teknologisk Institut og Akademiet for de tekniske Videnskaber i samarbejde skulde nedsætte et udvalg til at lede forsøgene.

Laurits Andersens Fond tilskrev da Teknologisk Institut den 18/s 1938 som følger: „Under Henvisning til Deres Ansøgning af 28. Februar d. A. skal man herved meddele, at Bestyrelsen for Laurits Andersens Fond af Fondets Midler for 1938, 1939 og 1940 har bevilget et Beløb af Kr. 10.000 aarligt, at anvende til en Række Forsøg vedrørende Varmeisolering af Boliger og Boligopvarmning.“

Det er en Forudsætning for Beløbenes Bevilling, at Forsøgsarbejdet ledes af et af Akademiet for de tekniske Videnskaber nedsat Udvalg, i hvilket baade Fysikere, Fysiologer og Varmeteknikere er repræsenteret ....“

*P. O. Pedersen.*

Formand.

Den 29/6 1938 tilskrev Akademiet for de tekniske Videnskaber direktør Gunnar Gregersen som følger:

„Akademiraadet har paa sit 10de Møde den 21. Juni 1938 vedtaget at ville nedsætte et Udvalg til at forestaa visse varmetekniske Undersøgelser, særligt vedrørende Straalevarmens fysiologiske Virkninger, som har været foreslaaet udført af Teknologisk Institut, og hvortil Laurits Andersens Fond har bevilget 10.000 Kr. aarligt i 3 Aar paa Betingelse af, at Forsøgsarbejdet ledes af et af Akademiet nedsat Udvalg, i hvilket baade Fysikere, Fysiologer og Varmeteknikere er repræsenteret. I Udvalget er følgende blevet anmodet om at indtræde:

Professor, Dr. phil. August Krogh som Formand,  
 Professor H. Bache som Næstformand,  
 Professor F. C. Becker,  
 Dr. phil. E. Hohwü Christensen,  
 Læge Sven Christiansen,  
 Direktør Gunnar Gregersen,  
 Dr. phil. O. M. Henriques,  
 Professor E. S. Johansen.

Man har desuden anmodet følgende Foreninger og Institutioner om at udpege hver en Repræsentant:

Akademisk Arkitektforening,  
 Dansk Ingeniørforening,  
 Fællesrepræsentationen for Dansk Haandværk og Industri,  
 Industriraadet.

*P. O. Pedersen*

Præsident“.

De i akademiets skrivelse af 29/6 1938 nævnte organisationer udpegede medlemmer som følger:

Akademisk Arkitektforening: Arkitekt Mogens Koch,  
 Dansk Ingeniørforening: Overingeniør Carl U. Simonsen,

Fællesrepræsentationen for Dansk Haandværk og Industri:

Overingeniør Carl Bruun,  
Industriraadet: Civilingeniør A. von der Lieth.

Efter forhandling indtraadte yderligere vicedirektør P. Hempel, Teknologisk Institut, i udvalget ved dets nedsættelse.

Jævnsides med de ovennævnte forhandlinger mellem direktør Gregersen og professor P. O. Pedersen blev der forhandlet med forfatteren af dette afsnit om overtagelse af formandsposten, og jeg gav i skrivelse af 9/6 1938 tilsagn herom.

## BERETNING 1 B

### Kortfattet Oversigt over Udvalgets Arbejder

af

Afdelingsingeniør *Otto Juel Jørgensen.*

Paa Udvalgets konstituerende Møde den 26/9 1938 fremsatte Formanden, Professor Krogh, nogle Betragtninger om den foreliggende Opgave, bl. a., at Undersøgelserne vedrørende Boligopvarmning ikke alene var et varmeteknisk, men ogsaa i høj Grad et fysiologisk og hygiejnisk Spørgsmaal. Fuld Sagkundskab paa dette Omraade var der næppe nogen, der havde.

Det Kriterium, man skulde bruge for et Menneskes Sundhedstilstand, eksisterede ikke. Behageligheden var det eneste, vi kunde benytte i Øjeblikket. Imidlertid havde Læge John Olesen, der var meget interesseret i dette Problem, gjort en hel Del Iagttagelser, som bragte ham til at tro, at man ved en Vurdering af Hudens Tilstand kunde bedømme et Menneskes Sundhedstilstand, og det maatte blive en af Udvalgets første Opgaver at undersøge dette Spørgsmaal nærmere.

Man maatte begynde med at udarbejde Planer til et Forsøgs-kammer. Der fandtes saadanne Forsøgs-kamre, hvor man kunde variere Luft- og Vægteperaturerne uafhængigt af hinanden, dels i England og dels i Amerika, og det var Tanken, at Afdelingsingeniør Juel Jørgensen skulde foretage en Rejse til England for at se paa et saadant Forsøgs-kammer, ligesom Formandens Medarbejder, Dr. Marius Nielsen, der i Øjeblikket var i Amerika og i Forvejen var indstillet paa at skulle foretage Undersøgelser vedr. Menneskets Varmøkonomi, gjorde Studier hos Prof. Winslow i New-Haven, Connecticut, og saasnart Udvalgets Planer var udarbejdede, var det Tanken, at de skulde sendes over til Dr. Nielsen, som først vilde være tilbage i September 1939, til hvilken Tid det egentlige Forsøgsarbejde skulde paabegyndes, men forinden skulde Planerne være udført og de fornødne Forarbejder være gjort.

Opgavens Betydning kunde der ingen Tvivl være om, og Udvalget maatte derfor tage fat paa Løsningen af denne store Opgave, omend man paa flere Omraader stod paa bar Bund og saaledes maatte have en vis Tid til de forberedende Arbejder.

Man var enige om i det første Aar at samle Oplysninger om, hvilke Forsøg inden for Omraadet der var under Udførelse andre Steder, samt at foretage visse orienterende Undersøgelser bl. a. med Henblik paa Etablering af et Forsøgsrum med engelske og amerikanske som Forbilleder.

Som nævnt i ovenstaaende Uddrag af Referatet af første Møde havde man igennem Dr. Marius Niensens Besøg i U. S. A. og Afdelingsingeniør Juel Jørgensens og Civilingeniør O. G. Posselts Besøg i England Mulighed for at indsamle Oplysninger, som blev tilvejebragt og nyttiggjort ved Etablering af det af Udvalget benyttede Forsøgsrum, som er beskrevet i Beretning Nr. 2.

Ved Indretningen af dette Forsøgsrum er der gjort et stort og meget dygtigt Arbejde af Civilingeniør Lorents Pedersen, som paa Grundlag af de indhentede Oplysninger har udformet og gennemeksperimenteret alle Detailler vedr. Indretning af Forsøgsrummet og det dertil hørende maskinelle Anlæg og Automatik, ligesom han har foretaget Justering af alle Maaleapparaterne.

I Løbet af 1939 blev efter Drøftelse i Underudvalget (se S. 19) og Hovedudvalget indrettet det omtalte Forsøgsrum, som blev monteret i Teknologisk Instituts Lokaler og for de til Teknologisk Institut af Kraks Legat bevilgede Midler. I Foraaret 1940 blev Forsøgsrummet færdigbygget og justeret, og man drøftede Paa-begyndelse af fysiologiske Forsøg.

Ved den ændrede Brændselssituation, som opstod efter Besættelsen den 9. April 1940, drøftede man i et Møde, om man skulde omlægge Forsøgsplanen, saaledes at man først burde gaa i Gang med at undersøge, om Varmeisolering af Ydervægge m. m. i Bygninger vilde give en ekstra Besparelse ved diskontinuerlig Opvarmning.

Efter en Drøftelse i Hovedudvalget var der udelt Tilslutning til en saadan Ændring i Forsøgsplanen, som derefter blev udarbejdet, hvorpaa Forsøgene blev paabegyndt, og man optog efterhaanden flere Forsøgsrækker af saavel varmeteknisk som fysiologisk Art.

Uden at komme ind paa Detailler skal det nævnes, at man i det omtalte Forsøgsrum udførte Forsøg over Varmeforbruget ved

diskontinuerlig Opvarmning, naar Rummets Vægge var uisolerede henholdsvis isolerede udvendig eller indvendig, idet Termostaten „Jernhenrik“ blev benyttet som Indikator for Opvarmningstilstanden.

Da den fysiologiske Reaktion overfor forskellige Opvarmningsformer maa være Kriteriet for Opvarmningstilstanden, blev ovennævnte Forsøg, som forud planlagt, suppleret med Forsøg, under hvilke der opholdt sig Forsøgspersoner i Forsøgsrummet.

I Planen indgik ogsaa Forsøg vedr. Varmeisolering af Væggene med reflekterende Tapeter, dels med Radiator ved Gulvet, dels med Varmeslanger ved Loftet (Refleksvarmeanlæg) — som angivet af Overingeniør Carl Bruun.

Ved Gennemførelsen af de ovennævnte Forsøg havde man arbejdet med Opvarmningstilstande, ved hvilke der ikke var grelle Differenser imellem Overfladetemperaturerne af de forskellige begrænsende Flader i Forsøgsrummet. Da man imidlertid maatte anse det for vigtigt at blive orienteret om den fysiologiske Virkning af en ensidig Varmeudveksling imellem et Menneske og en kold Flade, f. Eks. en Væg, anstillede man Forsøg herover paa Universitetets Zoofysiologiske Laboratorium.

Foruden de omtalte Laboratorieforsøg har Udvalget ogsaa paa begyndt nogle Undersøgelser af Opvarmningsforholdene i Praxis i forskellige Boligtper i By og paa Land.

Endelig skal nævnes nogle Undersøgelser, der er udført vedr. Varmestraaling fra den menneskelige Hud, Forsøg som ogsaa er udført paa Universitetets Zoofysiologiske Laboratorium.

Gennemførelsen af de forskellige planlagte Forsøg har været overdraget til Forsøgsledere; disse er: Dr. phil. Marius Nielsen, som er knyttet til Universitetets Zoofysiologiske Laboratorium, og Civilingeniør Lorents Pedersen, som er knyttet til Teknologisk Instituts varmetekniske Afdeling. Sidstnævnte har været assisteret og under et kortere Fravær afløst af Civilingeniør Preben Kristiansen.

Maalingerne i Praxis har været udført af Ingeniør H. B. Jespersen, der ligesom Civilingeniør Kristiansen er knyttet til Teknologisk Instituts varmetekniske Laboratorium.

Gennemførelsen af saa omfattende Opgaver medfører, at der maa udformes og gennemprøves forskellige til Formaalet særlig egnede Aggregater — saaledes ogsaa i nærværende Tilfælde. Saaledes har Udvalgets Formand, Professor, Dr. phil. August Krogh, angivet og afprøvet en saakaldt Mikroklimatograf, et lille Appa-

rat, der kan anbringes paa en Forsøgsperson og kontinuert vil registrere Temperatur og Fugtighedsgrad paa det paagældende Sted, og endvidere et Apparat til Maaling af vævede Stoffers varmeisolerende Egenskaber. Begge er omtalt i Beretningerne, men sidstnævnte Maaleapparat har ikke været benyttet i større Omfang, da det endnu ikke har været muligt at optage herhenhørende Undersøgelser paa Arbejdsprogrammet. Dr. phil. Marius Nielsen, som fra sin Rejse i U. S. A. medbragte et Apparat til Maaling af Overfladers Straalingstal, har afprøvet det og benyttet det ved forskellige af Udvalgets Undersøgelser.

Endelig skal det anføres, at Termostaten „Jernhenrik“ har været grundigt gennemprøvet og som Indikator sammenlignet med Forsøgspersoners subjektive Fornemmelser.

Udvalgets Formand har under en Rejse i U. S. A. i 1946 erfaret, at man paa amerikanske Laboratorier, som arbejder med lignende Opgaver som Boligopvarmningsudvalget, under Krigen har konstrueret og bygget ganske lignende Termostater, der har været benyttet som Indikatorer for Beboelsesrums Opvarmnings-tilstande og til Undersøgelser over Klædedragtens varmeisolerende Egenskaber.

Under Drøftelserne af Udvalgets Forsøgsplaner og hidtil udførte Arbejde rejste Professor Becker i Efteraaret 1943 en Kritik mod de udførte varmetekniske Forsøg. Professoren har senere uddybet sin Kritik og udvidet den til ogsaa at omfatte andre Forsøg.

Ihvorvel Udvalgets Opgave fornemmelig maa være at udføre Forsøg, har man dog ment ogsaa at burde optage enkelte andre Opgaver.

Spørgsmaalet Varmeisolering af Bygninger har man anset for at være et vigtigt Spørgsmaal, som i Praksis næppe kan fremmes, uden at Kreditinstitutionerne ved Laangivning vil tage Hensyn til udførte varmeisolerende Foranstaltninger.

Udvalget indledede og førte derfor i 1942 nogle Forhandlinger med Kredit- og Hypotekforeningerne, hvilke resulterede i et Møde den 13/11 1942, ved hvilken Lejlighed praktisk talt alle Landets Kredit- og Hypotekforeninger var repræsenterede og fik Meddelelse om Udvalgets Opgaver og hidtil udførte Arbejde, ligesom man redegjorde for Udvalgets Syn paa Spørgsmaalet Varmeisolering.



Man tør vist sige, at Mødet resulterede i, at der blandt Kredit- og Hypotekforeningerne overfor Spørgsmaalet blev skabt en Goodwill, som gav sig det praktiske og øjeblikkelige Udslag, at „Kreditforeningernes Staaende Fællesudvalg“ lod sig repræsentere i Udvalget ved Kreditforeningsdirektør, Arkitekt Niels Pedersen.

Omkring Nytaar 1942-43 planlagde man Afholdelse af den første danske Varmekongres. For at undgaa Indblanding fra tysk Side, herunder at man skulde blive paatvunget tyske Foredragsholdere, gav man ved Forberedelserne det hele Karakter af enkelte Foredrag. Kongressen blev afholdt i Dagene den 15.—17. April 1943 i Dansk Ingeniørforenings Lokaler. I Kongressen deltog 256 danske Fagfolk, og der blev afholdt nedenfor nævnte Foredrag:

Professor, Dr. phil. August Krogh: „Boligopvarmningsproblemet fra et fysiologisk Synspunkt“.

Overarkitekt M. K. Michaelsen: „Boligopvarmningsproblemet fra et bygningsteknisk Synspunkt, suppleret med Eksempler paa Bygningsisolering i Praksis“.

Civilingeniør, Dr. techn. Erik V. Meyer: „Beregningsgrundlag for Bygningers Varmeisolering“.

Overingeniør Carl U. Simonsen: „Boligopvarmningsproblemet fra et privat og nationaløkonomisk Synspunkt“.

Overingeniør Carl Bruun: „Betragtninger vedrørende Straalevarme“.

Civilingeniør O. G. Posselt: „Skorstene og Løbesod“.

Afdelingsingeniør O. Juel Jørgensen: „Beskrivelse af Boligopvarmningsudvalgets Forsøgsrum samt nogle foreløbige Meddelelser om udførte Forsøg“.

Professor F. C. Becker: „Kritisk Gennemgang af det nu almindelig anvendte Beregningsgrundlag for Varmeanlæg og disses Udførelse“.

Civilingeniør Filip Ahlrén, Gøteborg: „Centralvarmeanlæg med lokal Regulering og rationel Varmemaaling“.

Direktør Niels Pedersen, Østifternes Kreditforening: „Kreditinstitutionernes Indstilling overfor Boligens Kvalitet“.

Stadsbygmester Svend Møller: „Myndighedernes Indstilling til Boligens Kvalitet“.

Ud fra den Betragtning, at Vinduet — taget i Almindelighed — er den Del af Yderfladen, der har det største Transmissionstal og de største Lækager, samt at de gængse danske Vindueskon-

struktioner i Særdeleshed kunde trænge til en Forbedring, satte Udvalget Spørgsmaalet paa sin Dagsorden i 1941.

Resultatet af Udvalgets Overvejelser blev, at man besluttede sig til at udskrive en Konkurrence i den Hensigt at fremkalde bedre Konstruktioner af Vinduer, herunder ogsaa Forbedring af Detailkonstruktioner.

Da man havde udformet sine Planer og forelagde dem for Udvalgets Resortministerium, Indenrigsministeriet, viste det sig, at man i Ministeriet, ganske uafhængig af Udvalgets Arbejde, havde planlagt et lignende Arbejde, som man fra Ministeriets Side havde tænkt sig at føre frem gennem „Indenrigsministeriets Opvarmningsudvalg af 1941“.

Efter nogle Forhandlinger om Spørgsmaalet besluttede Boligopvarmningsudvalget at afgive denne Opgave til Indenrigsministeriet, og den gled dermed ud af Udvalgets Arbejdsprogram.

Efterhaanden, som Udvalgets Arbejde voksede i Omfang, kom det til at staa Udvalgets Medlemmer mere og mere klart, at det vilde være nyttigt at udforme ganske bestemte Regler for Planlægning og Gennemførelse af Udvalgets Forsøgsarbejder, og man besluttede da i 1945 at nedsætte et „Vedtægtsudvalg“, som fik til Opgave at udarbejde Vedtægter for Udvalgets Sammensætning, Forretningsgang og Organisation af Forsøgsarbejdet m. v.

Dette Underudvalg udførte et stort og grundigt Arbejde og havde bl. a. Konference med Forstander, Civilingeniør A. C. Andersen, som velvilligt stillede sine rige Erfaringer fra sin Virksomhed i Statens Husdyrbrugsudvalg vedrørende Gennemførelsen af analogt Forsøgsarbejde til Raadighed for Udvalget.

Et af „Vedtægtsudvalget“ udarbejdet Forslag blev senere vedtaget af Hovedudvalget og fremsendt til Akademiet for de tekniske Videnskaber og Teknologisk Institut.

Vedrørende Udvalgets Organisation og Sammensætning skal sluttelig gives nogle faa Oplysninger.

Oprindeligt var Udvalget sammensat som angivet i Beretning Nr. 1 A. I Tidens Løb er der sket følgende Ændringer:

Udtraadt: Dr. phil. Hohwü Christensen 1942.

Professor Bache 1945.

Indtraadt: Direktør, Civilingeniør J. Falck 1940.

Afdelingsingeniør Otto Juel Jørgensen 1942.

Direktør, Arkitekt Niels Pedersen 1942.

Professor J. L. Mansa 1944.

Til at planlægge og lede Udvalgets Undersøgelser blev i Udvalgets første Møde nedsat et Underudvalg bestaaende af:

Professor August Krogh (Formand),  
Overingeniør Carl Bruun,  
Vicedirektør P. Hempel,  
Professor E. S. Johansen.

Udvalget, som senere blev benævnt Forsøgsudvalget, er undergaaet følgende Ændringer:

Udtraadt: Vicedirektør P. Hempel.

Indtraadt: Overingeniør Carl U. Simonsen 1941.

Afdelingsingeniør Otto Juel Jørgensen 1942.

Professor J. L. Mansa 1944.

I 1943 besluttede Hovedudvalget at nedsætte et Underudvalg, som skulde tage sig af den mere praktiske Side af Udvalgets Arbejder, medens det eksisterende Underudvalg (Forsøgsudvalget) skulde beskæftige sig med Forsøgsarbejdet.

Det nye Underudvalg: „Det tekniske Udvalg“ fik følgende Sammensætning:

Overingeniør Carl Bruun,  
Vicedirektør P. Hempel,  
Afdelingsingeniør Otto Juel Jørgensen,  
Arkitekt Mogens Koch,  
Direktør Niels Pedersen,  
Overingeniør Carl U. Simonsen.

Det ovenfor nævnte Vedtægtsudvalg bestod af nedennævnte Medlemmer:

Professor F. C. Becker,  
Direktør J. Falck,  
Overlæge O. M. Henriques,  
Afdelingsingeniør Otto Juel Jørgensen,  
Professor J. L. Mansa,  
Overingeniør Carl U. Simonsen.

Paa Grund af de skærpede Forhold under Besættelsen maatte i Sommeren 1944 saavel Læge Sven Christiansen som Udvalgets Formand, Professor August Krogh, rejse til Sverige. Samme Aar var 2 af Udvalgets Varmeingeniører fraværende i længere Tid paa Grund af Sygdom, saaledes at der en Overgang af Forsøgsudvalgets Medlemmer kun kunde samles 3, periodevis 2 til Møde.

Disse Forhold i Forbindelse med Bombningen af Teknologisk Institut den 21. Marts 1945 lagde givetvis betydelige Hindringer i Vejen for Udvalgets Virksomhed og forsinkede Arbejdet betydeligt. Under Formandens Fravær fungerede Akademiets Præsident, Professor Engelund, som Formand.

I Maj 1945 havde Udvalget den Glæde atter at se Læge Sven Christiansen og Formanden vende tilbage til Arbejdet.

I Løbet af 1945 sluttede det egentlige Forsøgsarbejde. Nogle af de Beretninger, som nu udsendes, var da i Hovedsagen udarbejdede, medens Redaktionen af andre først kunde afsluttes i 1946.

Idet Boligopvarmningsudvalget hermed udsender 12 Forsøgsberetninger bemærkes det, at der er endnu mange Opgaver at løse indenfor Boligopvarmningens Omraade, og man har indenfor Udvalget drøftet, henholdsvis skitseret, Planer for videregaaende Forsøg og Forsøgsrækker.

Man har imidlertid vedtaget nu at slutte Udvalgets Virksomhed som selvstændigt Udvalg, idet man formoder og haaber, at de Opgaver, man har drøftet, vil blive taget op og løst af Statens Byggeforskningsinstitut, der som bekendt nu er en Realitet.

## Preface.

In publishing a series of reports on experiments carried out the Committee for the Study of Domestic Heating wants to take this opportunity to give some information about its history and setting up, which is contained in the following Report No. 1 A. A brief summary of the work of the committee since its establishment is presented in Report No. 1 B.

The members of the committee are:

Professor August Krogh, Ph. D. (chairman),

Otto Juel Jørgensen, Department Engineer (secretary),

Professor F. C. Becker,

Carl Bruun, Engineer in Chief, representing The Joint Representation of Danish Handicrafts and Industries.

Dr. Sven Christiansen,

J. Falck, Civil Engineer, representing the Manufacturer of Stoves.

Gunnar Gregersen, Director, Technological Institute,

P. Hempel, Vice-director, Technological Institute,

O. M. Henriques, Ph. D.,

Professor E. S. Johansen,

Mogens Koch, Architect, representing the Association of Architects qualified at the Royal Academy.

A. von der Lieth, Civil Engineer, representing the Danish Federation of Industries.

Professor J. L. Mansa,

Niels Pedersen, Director of the Land Credit Association of the Islands Dioceses, representing the Permanent Joint Committee of the Land Credit Association.

Carl U. Simonsen, Engineer in Chief, representing the Association of Danish Civil Engineers.

The committee publishes the following reports:

No. 1 A. Professor August Krogh, Ph. D.:

THE HISTORY OF THE COMMITTEE FOR THE STUDY OF DOMESTIC HEATING.

No. 1 B. Otto Juel Jørgensen, Department Engineer:

A SHORT SUMMARY OF THE WORK CARRIED OUT BY THE COMMITTEE IN THE YEARS 1938—1945.

No. 2. Lorents Pedersen, Civil Engineer:

EXPERIMENTS WITH INTERMITTENT HEATING AND INSULATION CARRIED OUT IN A TESTROOM.

No. 3. Marius Nielsen, Ph. D.:

STUDIES ON THE RELATION BETWEEN THE SENSATIONS OF COMFORT, DEGREE OF HEATING AND PHYSIOLOGICAL REACTIONS.

No. 4. Marius Nielsen, Ph. D.:

ON THE IMPORTANCE OF HEATING OF FLOORS FOR THE SENSATION OF COMFORT AND THE TEMPERATURES AT THE LOWER EXTREMITIES.

No. 5. Professor August Krogh, Ph. D.:

A MICRO CLIMATE RECORDER.

No. 6. Professor August Krogh, Ph. D.:

THE HEAT INSULATING PROPERTIES OF TEXTILES.

No. 7. Marius Nielsen, Ph. D.:

STUDIES ON THE HEAT RADIATION CAPACITY OF THE HUMAN SKIN.

No. 8. Carl Bruun, Engineer in Chief:

PRACTICAL EXAMINATIONS CONCERNING REFLEX HEATING PLANTS.

No. 9. Marius Nielsen, Ph. D.:

STUDIES ON THE EFFECT ON UNILATERAL COOLING BY RADIATION.

No. 10. Lorents Pedersen, Civil Engineer:

THE EMISSION OF HEAT BY RADIATION AND CONVECTION FROM A FULLY DRESSED PERSON.

No. 11. Lorents Pedersen, Civil Engineer:

MEASUREMENTS OF TEMPERATURES IN DIFFERENT  
TYPES OF DWELLINGS.

No. 12. Carl Bruun, Engineer in Chief:

COMPARISON OF MEASUREMENTS AND  
CALCULATIONS OF HEAT-CONSUMPTION.

I want to take this opportunity to express my acknowledgment to the institutions which set up the committee and later in various ways supported it in its efforts, thus making it possible to start and carry through the work here dealt with. I also want to express my gratitude to the Government Building Board and the 3 foundations: The Laurits Andersen Foundation, the Otto Mønsted Foundation and the Thomas B. Thrige Foundation, for their contributions, totaling ca. 230.000 Kr., which have provided the economic basis for the work of the committee, and to the Krak Fund, which by granting a contribution at 22.500 Kr. to the Technological Institute made it possible to build the test room used by the committee. Last but not least I want to express my heartfelt thanks to all the members of the committee and especially the experiments committee who have contributed their share to the solution of the common task, to the investigators and their assistants, who have, each of them, done their share of the great and often troublesome work in connection with the experiments, the administrative work, and the numerous discussions on the physiological and technical problems, all of them so closely interwoven.

A number of results have in this way been achieved which the committee hereby begs to submit for publication, and it is the hope of the committee that with this work Denmark may have contributed something to the solution of some problems which are also being examined elsewhere. Many of the problems are still awaiting their solution, but it is to be hoped that it may be possible to proceed with the work thus started also in the years to come.

*August Krogh.*

## REPORT No. 1 A

### **The History and Setting up of the Committee.**

Reported by

AUGUST KROGH

At the international heating congress in Wiesbaden in 1927\*), Carl U. Simonsen, Engineer in Chief, in a contribution to the discussion pointed out how the emission of heat from the human body varies with the air temperatures of a room, and in particular with the temperature of the inner surfaces of the walls; foreseeing that here was a domain which called for further investigations, Mr. Simonsen advocated the cooperation of thermo-technicians, architects, the public authorities and the land credit associations.

It is only fair on this day of publication of the report on the work carried out by the Committee, to call to mind that as early as 1927 Mr. Simonsen saw what the problems were and realized the necessity of taking them up jointly for solution.

In his capacity of chief of the thermo-technical department of the Technological Institute Mr. O. Juel Jørgensen set up, in 1926, a thermo-technical laboratory which, with particular reference to the problem of heat insulation of dwellings, was especially equipped for the determination of the heat conductivity of textiles and the undertaking of other thermo-technical measurements. In this connection it should be mentioned that the department did not only concern itself with the technical economic aspect of the matter, but sought the cooperation of experts within physiology and medicine at an early date; thus valuable cooperation was first established with Dr. John Olesen, and later — in 1935 — the department arranged an unofficial and unbiassed discussion between a number of doctors and engineers

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\*) Kongres für Heizung und Lüftung 8.,—11. Sept. 1927, Bericht II, p. 52—57.



about the physiological and technical problems of the heating of dwellings.

At the same time, in the years 1935—39, the department had at its disposal a test flat in Østbanegade in Copenhagen, in which various preliminary measurements were carried out as a preparation to subsequent studies.

With a view to the investigations to be undertaken Mr. Otto Juel Jørgensen had, in 1936, designed and made a thermostat of the same form and size as a human being. The thermostat was made from sheet copper, and inside it there were electrical heating elements, so that the thermostat could be heated up and the surface of it adjusted automatically to any temperature desired; by being heated to the same temperature as that of the human body it might be used as an indicator of the heating condition of a room. In the course of the spring of 1937 it was „tuned in“ and adjusted, and thereafter used in making the above-mentioned measurements in the test flat. As mentioned in Reports No. 2, 3 and 10 this thermostat was used in a number of the experiments carried out by the committee.

Further it should be mentioned that Carl Bruun took the initiative and, in practice as well as in the laboratory, carried through a series of fundamental investigations of various forms of radiant heat, investigations which have left their mark on the work of the committee.

Independent of the above preparatory work the chief of the laboratory of the Finsen Institute, O. M. Henriques, Ph. D., had carried out a series of experiments on the radiation of heat from the human organism. The object of the thermo-technical department of the Technological Institute was now to take up the problem of the heating of dwellings for a thorough investigation in cooperation with the medical profession, and after a preliminary exchange of views about the problems in question the result was that negotiations were opened in 1937/38 between the Technological Institute and the Finsen Institute with a view to the establishment of cooperation relative to the investigations concerned. Almost at the same time papers were read by Messrs. Henriques, Juel Jørgensen and Simonsen in the Association of Danish Civil Engineers and Medicinsk Selskab on the problem — which seemed to suggest that medical men as well as engineers were keenly interested in the subject.

The outcome of the preparatory work and the discussions was

that the thermo-technical department of the Technological Institute in February and June 1938 asked the Laurits Andersen foundation and the Krak Fund for grants of Kr. 30,000 and Kr. 22,000 respectively towards experimental work on the heating of dwellings.

The following passages from these applications may be cited:

„.... From the above brief observations it will be seen that if it is desired to go into the problem of heating of dwellings such investigation cannot be confined to an examination of the different heating systems and their function, but must be extended to include the planning of the dwelling in physiological-thermotechnical respect“.

Further: „.... and these (the physiological) questions being far from finally solved, they will have to be taken up for thorough investigation alongside with an examination of the technical problems. If the physiological and hygienic conditions are included in the investigations it is necessary that the experimental work should be undertaken in cooperation with members of the medical profession, it being for the latter to formulate the requirements which the dwellings and heating plants must satisfy for physiological and hygienic reasons ....“.

Finally: „It is therefore to be emphasized that in carrying out the experiments it will be imperative that close cooperation should be made possible between doctors and thermo-technicians“.

At the annual festival of the Technological Institute in May 1938, Mr. Otto Juel Jørgensen read a paper on the heating of dwellings. In this paper the necessity was stressed of taking up the problem of heating of dwellings for examination in cooperation between physiological-medical experts and thermo-technical experts, the paper being entirely on a line with the above-mentioned applications.

The application from the Technological Institute to the Krak Fund was granted, whereas the application from the Institute to the Laurits Andersen Foundation had the result that the president of the foundation, Professor P. O. Pedersen, informed Director Gunnar Gregersen that the foundation was considering to grant the application, but on condition that the experiments were carried out under the auspices of a committee to be appointed by the Academy of the Technical Sciences.

After negotiations carried on between Director Gunnar

Gregersen and Professor P. O. Pedersen the agreement was reached that the Technological Institute and the Academy of the Technical Sciences should jointly set up a committee to conduct the experimental work.

The Laurits Andersen Foundation thereafter, under date of March 18th, 1938, wrote the Technological Institute as follows:

„With reference to your application dated February 28th last, the trustees of the Foundation hereby beg to inform the Technological Institute that it has been decided to pay an amount of Kr. 10,000 annually for each of the years 1938, 1939 and 1940 towards a series of experiments on the heat insulation and heating of dwellings.

It is a condition for granting the amounts that the experimental work should be conducted by a committee to be appointed by the Academy for the Technical Sciences in such a way that both physicists, physiologists and thermo-technicians are represented in the committee ....

P. O. Pedersen,  
Chairman“.

Under date of June 28th, 1938, the Academy for the Technical Sciences wrote Director Gunnar Gregersen as follows:

„The Senate of the Academy has at its 10th meeting on June 21st, 1938, decided to set up a committee to take charge of certain thermo-technical investigations with particular reference to the physiological effects of radiant heat, which the Technological Institute has planned to carry out, and towards the performance of which the Laurits Andersen Foundation has granted an amount of Kr. 10,000 annually for 3 years, on condition that the experimental work is conducted by a committee in which physicist, as well as physiologists and thermo-technicians shall be represented. The following persons have been invited to form this committee:

Professor August Krogh, Ph. D., as chairman,  
Professor H. Bache, as deputy chairman,  
Professor F. C. Becker,  
E. Hohwü Christensen, Ph. D.,  
Dr. Sven Christiansen,  
Gunnar Gregersen, Director,  
O. M. Henriques, Ph. D.,  
Professor E. S. Johansen.

The following associations and institutions have moreover been requested each to appoint a representative:

The Association of Architects qualified at the Royal Academy,  
The Association of Danish Civil Engineers,  
The Joint Representation of Danish Handicrafts and Industry,  
The Federation of Danish Industries.

P. O. Pedersen,  
President“.

The organisation mentioned in the letter from the Academy dated June 29th, 1938, appointed the following persons as members of the committee:

The Association of Architects qualified at the Royal Academy:  
Mogens Koch, Architect.

The Association of Danish Civil Engineers: Carl U. Simonsen,  
Engineer in Chief.

The Joint Representation of Danish Handicrafts and Industry:  
Carl Bruun, Engineer in Chief.

The Federation of Danish Industries: A. von der Lieth, Civil  
Engineer.

Upon further negotiations P. Hempel, Vice-director of the Technological Institute, was appointed to the committee.

Alongside with the above negotiations between Director Gunnar Gregersen and Professor P. O. Pedersen, negotiations were carried on with the writer of this section about his taking over the chairmanship, and by letter dated June 9th, 1938, I expressed my willingness to do so.

## REPORT No. 1 B

### **Brief Summary of the Works performed by the Committee**

by

OTTO JUEL JØRGENSEN, Department Engineer.

At the constituent meeting of the committee on September 26th, 1938, Professor Krogh gave some general information about the task to be taken in hand, in which connection he stressed that the investigations on the heating of dwellings were not only

a thermo-technical problem, but were also in a very great measure a question of a physiological and hygienic nature. It was hardly possible to find anybody who was fully conversant with all the aspects of this problem.

The criterion by which to judge a person's state of health was non-existent. A feeling of comfort was the only thing we could go by at present. However, Dr. John Olesen, who was keenly interested in the problem, had made a series of observations which had led him to believe that the condition of the skin afforded basis for a judgment of a person's state of health, and it would have to be one of the first tasks of the committee to investigate this problem.

First of all, designs would have to be made for a test room. Such test rooms, in which the temperatures of air and walls could be varied, were in existence in both England and U. S. A., and it was the idea that Juel Jørgensen was to go to England to have a look at such a test room, also that the chairman's assistant, Dr. Marius Nielsen, who at that time was in U. S. A. and already knew that he might have to study the thermal economy of the human body, was to study this subject with Professor Winslow in New Haven, Connecticut, and it was the intention that as soon as the plans of the committee were ready, they were to be sent to America to Dr. Nielsen, who would not be back in Denmark till September 1939, when it was expected that the experimental work proper would be commenced, but before the experimental work could be started the plans would have to be ready, and the preliminary work completed.

There could be no doubt about the significance of the task, and the committee would therefore have to tackle the solution of this great task, although in more respects than one they would be called upon to do pioneer work, and consequently would have to be given a certain time for the preparatory work.

Everybody agreed to spend the first twelvemonth collecting information about the experiments which were being carried on elsewhere within this special province, and to make some preliminary investigations, i. a. with regard to the establishment of a test room on the prototype of the English and American ones.

As mentioned in the foregoing abstract of the report on the first meeting there was a possibility of collecting information through Dr. Marius Nielsen who was in U. S. A., and through Mr. Juel Jørgensen and Mr. O. G. Posselt who were going to

England. The information was procured and utilized in the arrangement of the test room used by the committee and described in Report No. 2.

In arranging this test room much fine work was done by Lorents Pedersen, civil engineer, who, on the basis of the information collected, planned and tested the installations of the test room in all its details with its mechanical plant and automatic apparatus, besides which he adjusted all the measuring instruments.

In the course of 1939, after discussion in the sub-committee (p. 34) and main committee, the above-mentioned test room was fitted up on the premises of the Technological Institute for the means granted by the Krak Fund. In the spring of 1940 the test room was completed and the instruments adjusted, and the starting of the physiological experiments was being discussed.

As a consequence of the altered situation following the occupation on April 9th, 1940, the committee in a meeting discussed the possibility of amending the plan of experiments in the manner that the problem to be tackled first was the question whether thermal insulation of outer walls, etc., of buildings would effect an additional saving by discontinuous heating.

After a discussion in the main committee everybody agreed to the proposed amendment of the experimental plan. The plan for the experiments was thereafter worked out, and the experiments begun, and in the course of time several experimental series were started of a thermo-technical as well as of a physiological nature.

Without going into detail it should be mentioned that in the oft-mentioned test room, which was fitted up in the Technological Institute, experiments were conducted on the consumption of heat by discontinuous heating with the walls of the room un-insulated, resp. insulated on the inner and outer sides, the thermostat I. H. being used as an indicator of the heating conditions.

As the physiological reaction to the various forms of heating must be the criterion of the heating condition, the above-mentioned were, as had been planned, supplemented with experiments during which human subjects were staying in the test room.

The plan also included experiments concerning thermal insulation of the walls by means of heat-reflecting wallpapers, some of them with radiators at the floor, others with heating pipes at the ceiling (reflex heating plant) — as indicated by Carl Bruun.

In carrying out these experiments, heating conditions had been employed in which the surface temperatures of the various bounding surfaces did not differ to any material extent. As, however, it was considered of importance to get to know something about the physiological effect of a one-sided heat transmission from a human being to a cold surface, e. g. a wall, experiments hereon were conducted in the Zoophysiological Laboratory of the University of Copenhagen.

In this laboratory were further conducted some investigations on the radiation of heat from the human skin.

In addition to the laboratory experiments mentioned, the committee also started some investigations on the heating conditions in practical life in dwellings of various types in towns and in the country.

The carrying through of the various experiments planned was entrusted to the following investigators: Marius Nielsen, of the Zoophysiological Laboratory of the University of Copenhagen, and Lorents Pedersen, civil engineer, of the thermo-technical department of the Technological Institute. The latter was for a short period assisted in his work by Preben Kristiansen, who also performed the work during Lorents Pedersen's absence for a short time.

The measurements in practice were carried out by H. B. Jespersen, mechanical engineer, who like Preben Kristiansen is attached to the thermo-technical laboratory of the Technological Institute in Copenhagen, under the charge of O. G. Posselt, civil Engineer.

The carrying through of so comprehensive tasks necessitates the designing and testing of various aggregates specially suited for the particular purpose — and that was the case here also. Thus the chairman of the committee, Professor August Krogh designed and tested a so-called Microclimatograph, a small apparatus which placed anywhere on a test subject will continuously register the temperature and degree of humidity at the place concerned, and further an apparatus for measuring the heat insulating properties of textiles.

Both are mentioned in the reports, but the last-mentioned apparatus has not been used to any great extent as it has not been possible so far to include the experiments concerned in the working programme. Dr. Marius Nielsen who brought with him from his journey in U. S. A. a small apparatus for measuring the

heat radiation figures from surfaces, has tested this apparatus and used it in various of the studies carried out by the committee.

Finally it should be stated that the thermostat I. H. has been tested and its registrations as an indicator been compared with the subjective sensations of the test subjects.

During a trip to U. S. A. in 1945 the chairman of the committee learned that the American laboratories concerned with similar tasks as those of our domestic heating committee, have during the war designed and built quite similar thermostats, which have been employed as indicators of the heating conditions of living rooms.

During the discussions on the experimental work and the results so far obtained Professor Becker, in the autumn of 1943, raised a criticism of the thermo-technical experiments. Professor Becker has later on further elaborated this criticism and extended it to include other branches of the work.

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Although the task of the committee should primarily be the carrying out of experiments, the committee has deemed it right and proper, however, also to take upon itself a few other tasks.

The committee considered the problem of heat insulation of buildings an important one, which could hardly be proceeded with in practice unless, when granting loans, the land credit associations were prepared to take into considerations the works which had been carried out in the buildings with a view to heat insulation.

The committee therefore, in 1942, had some preliminary discussions with the various land credit associations, with the result that on November 13th, 1942, a meeting was held at which practically all the land credit associations in the country were represented. At the meeting information was given about the tasks of the committee and the work which had so far been carried out, and the committee also gave an account of its view of the problem of heat insulation.

The committee is no doubt safe in stating that the result of the meeting was that a goodwill was created among the land credit associations in respect of the problem which had the practical and immediate manifestation that the permanent joint committee of the land credit associations immediately appointed



a representative to the committee, Director Niels Pedersen, Architect.

Around the turn of the year 1942/43 the holding of the first Danish heating congress was being planned. In order to avoid German interference and having German lecturers forced on us the preparations for the congress were made in such a way as to give the impression that it was the question of a number of separate lectures. The congress was held in the days 15—17 April 1943 in the building of the Association of Danish Civil Engineers and was attended by 256 Danish members. The following papers were read:

Professor August Krogh, Ph. D.: „The Problem of the Heating of Dwellings from a Physiological Point of View“.

M. K. Michaelsen, Chief Architect: „The Problem of the Heating of Dwellings from a Building-technical Point of View, Supplemented with Practical Instances of Building-Insulation“.

Erik V. Meyer, Civil Engineer, Dr. techn.: „Calculation Basis for the Heat Insulation of Buildings“.

Carl U. Simonsen, Engineer in Chief: „The Problem of the Heating of Dwellings from the Point of View of the Private Individual and the National Economy“.

Carl Bruun, Engineer in Chief: „Some Reflections on Radiant Heat“.

O. Juel Jørgensen, Civil Engineer: „Description of the Test Room Established by the Committee on the Heating of Dwellings and Provisional Reports on the Experiments Carried out“.

Professor F. C. Becker: „Critical Review of the Calculation Basis now Generally Employed for Heating Plants and their Construction“.

Niels Pedersen, Civil Engineer, The Land Credit Association of the Islands Dioceses: „The Attitude of the Land Credit Institutions to the Quality of the Dwelling“.

Svend Møller, of the Municipal Building Board: „The Attitude of the Authorities to the Quality of the Dwelling“.

On the view that, taken as a whole, the window is the part of the outer surface which has the highest heat transmittance coefficient and the greatest leakages and in view of the fact that the usual Danish type of windows stand in particular need of improvement, the committee put this question on the agenda in 1941.

The result of the deliberations of the committee was that it was decided to announce a competition in order to obtain better types of windows, including improvements of constructional details. When the committee had worked out its plans and submitted them to the proper Ministry, the Ministry for Interior Affairs, it proved that quite independently of the work of the committee the Ministry had planned work of exactly the same nature, which the Ministry intended to carry out through „The Heating Committee of the Ministry for Interior Affairs of 1941“.

After some discussions on the question the domestic heating committee decided to cede this task to the Ministry, and consequently it was left out of the working programme of the committee.

When gradually the work of the committee assumed ever increasing proportions it became more and more clear to the members of the committee that it would be expedient to lay down quite definite rules for the planning and carrying out of the experimental work to be performed by the committee, and in 1945 it was decided to set up a „Rules Committee“, charged with the task of drafting rules for the composition of the committee, the business routine, and the organisation of the experimental work.

This subcommittee performed an important and thorough piece of work and had amongst other things conferences with Leader of Experiments of the Government Livestock Committee, A. C. Andersen, civil engineer, who from his work in the said committee had great experience with regard to the carrying through of analogous experimental work.

The rules drafted by the „Rules Committee“ were later on approved by the main committee and submitted to the Academy of the Technical Sciences, and the Technological Institute.

Respecting the organisation and composition of the committee a few details are to be given.

The original composition of the committee was as indicated in Report No. 1 A. In the course of time the following changes have occurred:

Retired members: Hohwü Christensen, Ph. D., 1942.

Professor Bache, 1945.

New members: Director J. Falck, Civil Engineer, 1940.

Otto Juel Jørgensen, Departement Engineer 1942.

Director Niels Pedersen, Architect, 1942.

Professor J. L. Mansa, 1944.

At the first meeting of the committee a sub-committee was appointed to plan and conduct the investigations to be performed by the committee, consisting of the following members:

Professor August Krogh, (chairman),  
 Carl Bruun, Engineer in Chief,  
 P. Hempel, Vice-director,  
 Professor E. S. Johansen.

The committee, which was later on called the „experiments Committee“, has undergone the following changes:

Retired member: P. Hempel, Vice-director.

New members: Carl U. Simonsen, Engineer in Chief, 1941,  
 Otto Juel Jørgensen, Department Engineer,  
 1942,  
 Professor J. L. Mansa, 1944.

In 1943 the main committee decided to set up a sub-committee to take care of the practical work of the committee, whereas the existing sub-committee, the Experiment Committee, was to apply itself to the experimental work.

The new sub-committee, „The Technical Committee“, consisted of the following members:

Carl Bruun, Engineer in Chief,  
 P. Hempel, Vice-director,  
 Otto Juel Jørgensen, Department Engineer,  
 Mogens Koch, Architect,  
 Niels Pedersen, Director,  
 Carl U. Simonsen, Engineer in Chief.

The above-mentioned Rules Committee consisted of the following members:

Professor C. F. Becker,  
 J. Falck, Director,  
 O. M. Henriques, Chief Physician,  
 Otto Juel Jørgensen, Department Engineer,  
 Professor J. L. Mansa,  
 Carl U. Simonsen, Engineer in Chief.

Owing to the aggravating conditions during the occupation Dr. Sven Christiansen as well as the chairman of the committee, Professor August Krogh had to go to Sweden in the summer of 1944. The same year two of the thermo-technical engineers of the committee were absent for a lengthy period owing to illness, so that over a period the meetings of the committee were attended by only 3, and for a time only 2 members.

These factors coupled with the bombing of the Technological Institute on March 21st, 1945, naturally placed great obstacles in the way of the work of the committee and delayed it considerably. During the absence of the chairman, the President of the Academy of Technical Sciences, Professor Englund, was acting chairman.

In May 1945 the committee had the great pleasure that Dr. Sven Christiansen and the chairman were able to resume their duties.

In the course of 1945 the experimental work proper was brought to a conclusion. Some of the reports which are now being published were then ready for the press, while the final drafting of the other reports could only be completed in 1946.

The Committee for the Study of Domestic Heating hereby issues twelve reports on experimental work, and the members of the Committee wish at this opportunity to express as their opinion that many problems within the field of domestic heating are still unsolved, and plans for more extensive experiments and investigations have been discussed and, in some cases, drafted by the Committee.

It has, however been decided to terminate the activity of the Committee as an independent committee as it is assumed and hoped that the tasks which have been discussed will be taken up and fulfilled by the Government Building Research Institute which—as known—has now been established.