M I D W E S T R E S E A R C H C O U N C I L

PHILLIPS HOTEL, KANSAS CITY, MISSOURI

June 7th and 8th, 1943

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Comprising representatives from educational institutions in the following states:

Missouri

Kansas

Oklahoma

Nebraska

Iowa

Arkansas

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Kansas Geological Survey
Open-file Report

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OF
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MIDWEST RESEARCH COUNCIL

PHILLIPS HOTEL, KANSAS CITY, MISSOURI

Monday, June 7, 1943
Tuesday, June 8, 1943

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CALLED BY: Mr. J. C. Nichols, who presided.

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Sponsored by:

Mr. W. T. Grant, President, Business Men's Assurance Company
Mr. C. W. Allendoerfer, President, First National Bank
Mr. A. W. Zimmer, Manager, North Kansas City Development Company
Mr. Guy E. Stanley, Executive Assistant, Union Pacific Railroad Company
Mr. James M. Kemper, President, Commerce Trust Company
Mr. Grant Stauffer, President, Sinclair Coal Company
Mr. Charles Thompson, President, Thompson-Hayward Chemical Company
Mr. Lynwood Smith, President, American Dairies, Inc.
Major T. J. Strickler, V.P. and Genl. Mgr., Kansas City Gas Company
Mr. Chester Smith, President, Kansas City Power & Light Company
Mr. M. J. Stooker, Genl. Mgr., Western Mo.-Kans. area, of the Southwestern Bell Telephone Company
Mr. Roy Roberts, Managing Editor, Kansas City Star
Mr. Kenneth Spencer, Manager, Pittsburg & Midway Coal Mining Company
Mr. R. L. Gray, President, Sheffield Steel Corporation
Mr. C. J. Patterson, Chrmn. Board, Campbell-Taggart Research Corporation
Mr. George Breon, President, George A. Breon & Company
Mr. A. L. Gustin, President, Gustin-Bacon Manufacturing Company
Mr. J. C. Nichols, Chairman of Board, J. C. Nichols Companies

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Address of welcome by Mayor John B. Gage on behalf of Kansas City, and George Catts for the Chamber of Commerce.

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C. M. Woodward, Commissioner of Industry & Trade of the Chamber of Commerce was very helpful during entire conference.

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Dr. Roy Cross, President, Kansas City Testing Laboratory Company was cooperative in carrying out conference.

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The Kansas City Star was most interested; reporting the proceedings of the conference in extensive front page stories and several excellent editorials.

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Many interesting products resulting from research were on exhibition, and the walls were filled with informative maps.

P R E S E N T

Dr. Harrison Hale, Department of Chemistry, University of Arkansas

J. F. Price, President, Kansas State Teacher's College of Emporia

Deane Mallot, Chancellor, University of Kansas
Dean Ray Q. Brewster, Professor of Chemistry, University of Kansas
T. T. Costonguey, Chemical Research Department, University of Kansas
Dr. J. C. Frye, Geological Survey, University of Kansas
Dr. J. J. Jakosky, Department of Geophysics, University of Kansas

Dr. H. H. King, Department of Chemistry, Kansas State College
Dean L. E. Call, Department of Agriculture, Kansas State College
Dean R. A. Seaton, Dir. of Engr. Experiment Station, Kansas State College
Prof. R. I. Throckmorton, Department of Agronomy, Kansas State College
Dr. J. W. Greene, Department of Dehydration, Kansas State College

Dr. H. A. Buehler, Chief, Missouri State Geological Survey, Rolla, Mo.
Dean M. F. Miller, College of Agriculture, University of Missouri
Dean Harry A. Curtis, College of Engineering, University of Missouri
Dr. E. B. Branson, Professor of Geology, University of Missouri

Royce H. LeRoy, Department of Agriculture, Kansas City University
Leonard Sorg, Lecturer in Chemistry, Kansas City University
Dr. J. Franklin Lewis, Assoc. Professor of Chemistry, Kansas City University
Dr. Sidney E. Ekblaw, Assoc. Prof. of Geology, Kansas City University
Dr. L. A. Kimpton, Dean of College of Liberal Arts, Kansas City University

Dr. G. E. Condra, Chief of Div. and State Geologist, University of Nebraska
Dean O. J. Ferguson, College of Engineering, University of Nebraska
Dr. W. E. Militzer, Department of Chemistry, University of Nebraska

L. E. Hawkins, Vice-Dir. Agri. Experiment Station, Oklahoma A & M College

Dean W. H. Carson, College of Engineering, University of Oklahoma
R. L. Huntington, School of Chemical Engineering, University of Oklahoma
G. L. Cross, Acting Director, University of Oklahoma Research Institute
Robert H. Dott, Director, Oklahoma Geological Survey, Univ. of Oklahoma
A. L. Burwell, Oklahoma Geological Survey, Norman, Oklahoma

Dr. L. C. Heckert, Tech. Supt. Military Chem. Wks., (Pittsburg Tchrs. Coll.)

W. L. Nelson, Professor of Refining, University of Tulsa

Dr. Lloyd McKinley, Department of Chemistry, University of Wichita
Dr. Roy Cross, President, Kansas City Testing Laboratory
Dr. E. W. Reid, formerly Director of Research for Union Carbide Company
George G. Oberfell, Dir. Research, Phillips Pet. Corp., Bartlesville
J. O. Turner, Asst. Dir. of Research, Phillips Petroleum Corporation
Cary Wagner, Consulting Engineer for the Petroleum Industry

and others

MR. NICHOLS: Gentlemen; it is extremely gratifying to have you school men in attendance at this important meeting representing the states of Missouri, Kansas, Oklahoma, Nebraska, and Arkansas. I regret that Dr. O. R. Sweeney of Iowa State College could not be present, and that the University of Iowa was unable to send representatives at such short notice.

I feel this conference may prove of great importance to the middle west, and hope that our two days' schedule will give ample time to present and discuss some of our vital and common problems and opportunities. I hope great progress will come from this meeting and perhaps a permanent midwest research council which will be beneficial to both education and industry.

We cannot think of the future industrial horizon of our domain without considering its relation to synthetic chemistry.

Ponder for a moment the mysterious alchemy by which the gases of the air and the minerals of the soil are transmitted into waving grasses, and tossing foliage by the radiation of the sun.

As miraculous as it seems, synthetic chemistry today is outdoing nature in breaking down molecules in matter and rearranging atoms into articles of daily use and necessity. This juggling of atoms spells future industrial growth for the central U. S.

As I have said before, here in the middle west we have a "sleeping industrial giant" - - potentialities and possibilities unlimited in their scope - - there is no reason for ghost towns in our area - - a balance between agriculture and industry is our need today - - and our present horizon - - let us awaken our "sleeping industrial giant" by the blending of the whirr of the binder with the factory whistle bringing into being a song of prosperity for the middle west.

It seems to me an orderly approach for the course of this meeting would be first to have a rather short discussion about our products and resources. I ask Dr. H. A. Buehler, Director of the Geological Survey of Missouri to take up this subject first.

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DR. BUEHLER: Mr. Nichols (I feel you are doing a fine thing in bringing us together) and members of the conference, as Director of the Geological Survey I have been in this matter of research for a good many years and I have found three things rather necessary for carrying on successful research. The first thing is, you have got to have some brains in the organization, second, you have to have money, and third, you have to have time.

In our organization we have endeavored to make a very practical survey to get practical results and the development of the natural resources of the state are shown here on the walls in a series of maps which I have brought down here, and the specimens which show some of the products of industry that we have used, and here we have a number of pamphlets and publications which, if any of you are interested, I would like to have you take along.

The first and basic thing, of course, in a geological survey is to make a geological map.

This is a basic geological map here of the state and I want to direct special attention to the fact that the different parts of the state are under-lain by entirely different types of formations. In the Ozark region here in the southern half of the state, that is a province by itself, then we have the prairie country and the mineral resources here, which is again a province by itself. In other words, you can divide Missouri, as regards its mineral resources, into three

definite divisions. Practically all of our metallic resources occur in the Ozark region; the clays and coals are largely in the northern and western part of the state and I have here shown the distribution of the mineral resources as we know them today.

In the southwestern district here is the tri-state district of lead and zinc which produces about 30 per cent of the zinc of the country. Over here is the lead district of Missouri, which is the largest lead district in the world and which produces about 30 per cent of the lead ore produced in the United States. This is one of the finest mechanized series of mines anywhere in the country.

Just north of that we have an area producing barite. We produce about 50 per cent or a little more than 50 per cent of all the barite mined in the United States and here in Washington County they produce about 75 per cent of the state's production.

These areas here are two of our iron ore districts; these two properties here produced five million tons of ore but it has been idle now for about 40 years. Recently, however, we drilled it and found that there is more ore in sight on that property then was ever taken out, so we look for a development of the iron ore possibilities at Iron Mountain quite soon.

At the south end of the lead district we have another district containing cobalt, nickel, copper ore which is one of the most complex ores, which will run about 2 per cent lead, 2 per cent copper, about one-half per cent of nickel and one-half per cent of cobalt in an iron matrix.

In 1920 they spent a great deal of money developing that ore just before cobalt was discovered up north, and then they closed it

down and now because of the war necessity they are reopening that property. Just west of that we have some tungsten deposits in Madison County which have been worked in the past but just at present there does not seem to be very much tungsten there.

In this area shown in yellow we have the development of probably the highest grade refractory industry in the United States. It started in this little area here in St. Louis and the same formations are found over in Audrain County and there you have all the big manufacturing refractories of the United States in this district because it is a combination here of probably the finest and most extensive high grade clay deposits in the world; at least in the United States. In the southern part of the district extending down into the northern Ozarks we have these pot holes of flint, diaspore clay which they haul to the north and mix with the plastic clay to make high grade refractories.

This diaspore clay assays 75 per cent of aluminum and it could be used very well in the manufacture of aluminum if the deposits were large enough but they are probably not large enough to develop for aluminum but they are the basis for one of the greatest refractory industries in this country and I think the Missouri refractories are by far the highest grade in the United States.

Up here these purple spots in the northwest part of the state are the areas in which commercial coal has been developed and they extend from Barton County on the south to the Iowa state line and practically across the northern part of the state including the area around Kansas City. These green spots are small areas of oil and gas that we get in this part of the state and this is the only part of the state that has yet developed any material production of gas in these small fields.

Down here there is glass sand and lime and cement which you have out here at Sugar Creek. Those are the general developments and locations of the mineral industries of the state.

The Geological Survey has under its jurisdiction the matter of the surface waters of the state and the matter of the making of a topographic map of the state. Both of these are very basic factors in the matter of development not only of our mineral resources but our argricultural resources.

Here is a map showing the stations which we maintain in cooperation with the United States Geological Survey, which pays half of the expense. These areas here are proposed dam sites for flood control and for power generation in the state. We have been collecting statistics since 1921, and prior to that time there was not one application to the Federal Power Commission for the development of power in this state. Here is Bagnell Dam, Bagnell Dam could not have been built if it had not been for the records that we had collected as to the amount of water flowing down that stream. The Federal Power Commission will not license anyone to build a dam unless they can show the amount of power that can be generated, which cannot be shown without knowing the amount of water going down the stream, so that thirty-five million dollars development there was actually based on the records gotten up by this department.

There has been some high water here recently and we have probably gotten some of the most important records that are in existence because this last flood in the southern part of this state has been in excess of anything we ever had even in the 1844 flood, of a hundred years ago. A lot of these rivers went 3 or 4 feet higher than we have ever known of before. All of these proposed reservoirs have been based on our

records. If this one at Osceola had been built I do not think we would have had any real flood on the Osage; that would have retained the water.

I have a map back here showing the area that has been covered by topographic maps. We have covered about 50 per cent of the state with topographic maps. That work is carried on in cooperation with the United States Geological Survey and they pay half the cost. In this war program we have been consulted by the army engineers with regard to the location of these camps and airports and I do not believe it is any accident that every one of these munitions manufacturers, airports and cantonments have been located in areas where we have the topographic maps that the engineers can see what they are looking for, just by looking at a piece of paper prior to making their plans. In other words, practically everything that is located in this state has been located in areas where we have these topographic maps and I think that is an indication of the value of that part of our work.

Camp Leonard Wood was established in Pulaski County, brought down from Iowa when they found they could not get any water up there and they came to Rolla for a conference and we spent a day together and because we had the records of the water going down Piney River and could assure them they would have all the water they wanted for engineering replacement training and that they could have a 10 mile artillery range, they located that camp in this state. As a result there is a thirty-five or forty million dollar development that was based exactly on researches made by the Geological Survey.

I might mention one or two things we have done recently in the matter of the war effort. Here is a series of maps covering the geology of the Joplin district. That map shows all of the areas that

that have been mined in southwest Missouri in the lead and zinc district down here; it shows the trend of the ore production, it shows the character of the mining and shows the association of those ore deposits with these blue spots on the map which is a criterion as to where to develop next. We have been working on this a long time, it is not completed yet but when the war came on, in order that these men who wanted to develop, would have something to go on, we rushed these maps into print to show the entire development in southwest Missouri. Apparently from all we hear that has been a great help to the miners in the southwest part of the state and I might say we have just gotten out an oil and gas map of both Jackson and Cass counties showing all the past developments, all the past pools and discussing the type of structure in the remaining part of the counties that might be productive.

MR. NICHOLS: Thank you very much, Doctor. There isn't any question but what we have the resources, men; it is a question of really knowing what we have and being salesmen enough to present it well. Kansas got out a very fine map which was extremely helpful in directing the attention of eastern industrialists and the army at the time they were locating plants all over the country. I showed one of these maps to Mr. C. F. Kettering and a few days after that he wrote me that Mr. Davis, president of the United States Rubber Company was in his office and he was showing him one of these maps and said Davis was perfectly astounded at the proximity of a lot of materials that he, from a rubber standpoint, might be interested in. That is just an example of the help it will be if we can in some way present the proximity of our raw products in a good form to get the attention of the industrialists.

We have a number of purposes in this meeting but one of the things I hope will come out of it is that we can develop a composite map of this Middle Western area and before this meeting is over I suggest we name a committee that would study our whole area and produce a map similar to this or make some changes in it, if it is wise to do so, of this whole section in which we are so interested in the middle west.

That black and white map there on the wall shows the decline in population, and for 20 years we have been going down in population in this middle western area. You know the migration that has been going on and you know we have not been developing industrially, especially in our small towns, so out of this meeting perhaps we can "take a hitch in our belts", and improve this situation.

I ask Dr. Frye, Head of the Geological Survey of the State of Kansas, to tell you about the Kansas map.

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DR. FRYE: The preparation of a map of this kind involves many things that do not show on the map itself. This map is not a geological map. Dr. Buehler displayed a geological map of Missouri here. We have a similar type of map of Kansas showing the area of outcrop of the various rock formations. That sort of map is extremely useful to the geologists and technical men but it does not tell you where the various economic products are located and that is what we tried to do with this map.

The original idea of this type of map developed in the technical committees in the Kansas State Chamber of Commerce and I believe Mr. Nichols, himself, while in Washington, was the gentlemen who made the first suggestion that it would be very helpful if such a map were

available for him to show folks interested in locating industries in this area.

Dr. Buehler has given you a very good outline of the type of records necessary to be kept by a Geological Survey. The same applies to this map. It is based on records kept over many years, extending back over 30 years in this case.

The mineral resources of Kansas are roughly classified into four groups, fuels, consisting of coal, oil, gas and so forth; the metallic resources consisting of lead and zinc being the only important ones and being the extension of the Missouri district that the map prepared by the Missouri survey shows so well and also in the line of metallic resources we have pyrite and the third classification are non-metallic resources which include a very diverse group of materials, asphalt rock, that is rock impregnated with asphalt, diatomaceous marl - - those two materials have been developed to a very small extent in Kansas - - clay which is not the same quality of clay as Dr. Buehler told you about in Missouri but we have much more of it and it is useful for making light face brick and we think may serve as an important source of aluminum in case our bauxite reserves are depleted to a dangerous degree.

Another area of clay is in the southern part of the state and chalk is shown in the northwest part of the state. It compares very favorably with the English chalk, and some of the other things here are building stones, sand, gravel, rock wool material, gypsum, volcanic ash, bentonite, salt and so on, and the fourth general classification of mineral resources are water supplies.

In Missouri Dr. Buehler has told you stream gauging is a very important thing. It is likewise important in Kansas. Our stream flow

is very low and it is necessary in certain parts of the state to pump water from wells for agricultural, industrial, and municipal use. We have attempted to show on this map the areas in which large ground water supplies are available. You will notice in this part of Kansas we have one type of blue pattern which shows certain supplies, then in the southeastern corner of the state we have still another blue pattern which shows where deep rock supplies can be obtained. Along the streams you will notice we have a blue pattern overlying the stream course. In most of eastern Kansas and central and western Kansas that blue pattern does not exist primarily because the average stream flow is below 100 second feet and that is indicated by the absence of that blue pattern.

There are several things that must be taken into consideration in the preparation of a map of this type and that is because different resources are known to different degrees. For instance, in the case of fuel, we know pretty well what the area of our coal reserve is. This red pattern in the eastern part of the map shows the area that is underlain by coal. We may not know in extreme detail all of the area but in general we do know the area of Kansas that is underlain by coal. In the case of oil and gas that is not true as it was necessary to use a totally different type of presentation on this map. In the case of an oil or gas reserve you do not know it exists until you have it in production. Therefore the oil and gas areas shown are actual pool areas. In other words, there is a pool shown here for instance and over there is none; maybe tomorrow there will be one there so in the case of oil and gas reserves the picture is constantly changing.

A like difficulty occurred in the reproduction of clay reserves. In North central Kansas we have this area very well defined by five years of

research on light firing of refractory clays; we do know there are large shale and clay reserves in this part of Kansas, so general that it is practically all over this part of the map. In order to show that these materials were developed we simply showed on the map the brick, tile and pottery plants in the state. You will notice many places we have indicated the location of sand and gravel pits or stone quarries. I think most of you are aware of the fact we have very extensive building stone reserves in Kansas.

These are the places where a basis geological map is important. You can trace the area of out-crop of these various limestone and sandstones and so forth.

I believe that gives a fairly adequate background of the preparation of this map.

MR. NICHOLS: Thank you. Of course your map shows oil and gas pipelines and many other features. We will now hear from Dr. Harrison Hale, Head of the Chemistry Department of the University of Arkansas.

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DR. HALE: Each state is in a way unique and distinct. That is certainly true of Arkansas. Arkansas has the tradition and the heritage of the south and yet we are not of the Gulf south. We do not have a great deal in common with our neighbor on the East, Tennessee, except that Tennessee, particularly Memphis draws quite a bit of its strength from

Arkansas and the people in northeast Arkansas look to Memphis and read the Commercial Appeal instead of looking to Little Rock and reading the Arkansas Gazette, and yet it is true that Arkansas is in the Middle West and I was quite delighted when we were included in this conference here, and I wish to thank Mr. Nichols for including my state.

Very briefly, under four heads, I would like to give you a hurried survey of Arkansas's industrial resources and the first one of these which fits in with what these gentlemen said - - of course as a chemist and not as a geologist I cannot begin to give you in detail that which they have given you, but the first thing in our mineral resources would be aluminum. For approximately 50 years Arkansas has usually produced over 90 percent of all the bauxite produced in the United States and yet until within the last year there has not been a single pound of commercial aluminum produced there. Just recently there has been built in the state a very fine plant from a chemical engineering standpoint at Hurricane Creek. I was there about 6 weeks ago and I saw in one pile a million tons of bauxite and the thing that impressed me tremendously was the fact that they now can profitable remove, and by the new process, work ores that have not been used at all before. Of course, bauxite for the production of aluminum and also for refractories is by no means the only mineral resource of the state. Natural gas and oil have been produced in the state for a long time; oil for about 20 or 25 years, natural gas for much longer and in recent times we have discovered we do not know how much but apparently unlimited supplies of so-called sour gas which, I presume all of you know, is natural gas with

some hydrogen sulphide in it which gives an unlimited source of power. There are, of course, other minerals, mercury, etc. that can be produced. We have one rather large cement plant in the state. We produce some zinc, we have a number of clay plants in the state and I could give you a great many more but I no doubt will omit some in this hurried effort.

In addition to our mineral resources we have our agricultural resources. Arkansas usually ranks third in the production of cotton and yet there are very few cotton mills in the state.

We formerly claimed to have the largest peach orchards in the world near Nashville and in the northwest two counties of the state more apple trees than any other two counties in the United States. I doubt if that is now true. In certain areas in the state there are areas for the production of strawberries, cantaloupe and watermelons. Recently there has been a great development in the canning industry which comes over on the Missouri map, on the north. We are just getting started in the canning of tomatoes. There has been developed the poultry and egg industry. My home county which is Washington County is almost up in Missouri, there is just one county in between the state line and Washington County, and our chief crop at the present time is broilers and more cash money comes from that than any other crop. To give you an idea of the variety of our crops the Chamber of Commerce in Fayetteville says there are seven cash crops which are supposed to yield a million dollars a year.

In addition to these resources we have forestry. Arkansas has long been known for its production of lumber. Unfortunately for us, most of that lumber has been shipped out; much of it has come here, I understand. However, there are some furniture factories that are quite successful and during the last ten years or so there has been a more intelligent handling of our forests than we have ever had before. We have a state forestry administration that has been relatively free from political influence and we have a cash crop of timber that will be, we think, quite a resource for the state.

At Crossett and Camden there are two large paper mills and they do not mine the timber but harvest the crop and they have a large enough supply for continuous production year after year. At Crossett they not only make paper and lumber but they have the Crossett Chemical Company which uses the oak that cannot be used for lumber and they distill it and make various chemical products from it. Unfortunately, most of our raw products or many of them have been shipped out of the state.

We have one resource that cannot be shipped out of the state and that has been growing in importance in recent years until due to the war, lack of transportation made it so we could not use it and that is the beauty of our scenery and our summer resort weather. Our climate, instead of being a handicap, as we used to think it was, we are beginning to think of it as an advantage. It costs less to build a plant where you don't have to insulate as much as you do further north.

I am not giving you a complete report nor am I boasting. I simply want to set this thing before you and in that same spirit I would like to

refer you to the situation which we now face of the development that has came as a result of the war.

I mentioned the aluminum situation. Something like five hundred million dollars has been spent in the state as a war development and how we can maintain these plants and put them to use is a very real problem. I am glad to say there is a new spirit that has developed in recent years within the state. The Arkansas Industrial and Agricultural Commission has been active for a number of years through different administrations. The same thing is true of the State Planning Board and we have just been making a very determined effort to meet a popular demand to coordinate all these agencies. Our last legislature early this year passed a resolution appointing a committee from the senate to do that very thing and I know one of the plans that is being considered by them is the coordination of all of these plants working with a research council to be set up at the University of Arkansas.

Consequently, your invitation came at such a psychological time that you can see we are all set and all ready to cooperate just as fully as we possibly can with the plan that is at the bottom of this conference.

MR. NICHOLS: I think one of the things we want to have in mind in this whole conference is thinking of the things that can be made in our small towns. There isn't anything that brings prosperity more rapidly than to have a widely distributed industrial development not only in the

big cities but in our small towns. I am glad to know you have several canning factories - perhaps in small towns.

DR. HALE: In Pine Bluff we calim to make the best bows and arrows in this state.

MR. NICHOLS: Another thing is the need of a very fine technical research library here in the Middle West. There is a bare possibility that a fund that has been left in this city might result in our establishing a very large technical research library that would be available to all the schools in this area that might not have funds to make a complete library of their own and it would be particularly valuable to all of the industries in the Middle West. I would like to have a discussion before this meeting is over of the benefits of a fine research library. The trust fund says the library must be established in Kansas City.

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As an example of the magic of research, I am going to have Mr. Elmer Pierson give you a demonstration of a little mechanism from the Vendo Company and let him tell you about this little mechanism.

MR. PIERSON:

MR. NICHOLS, DISTINGUISHED GUESTS AND GENTLEMEN:

I congratulate you for arranging this conference, and am pleased to see such an excellent representation from several near by states. This is only typical of your efforts, Mr. Nichols, over the past many years for our area. We in industry are of the opinion a much closer cooperation between schools of learning and industry would be of untold benefit to the public.

This can be best accomplished by industry understanding your problems and goals and you in turn familiarizing yourselves with some of our somber

development problems. I trust this conference will be the first of many out of which should come some specific, planned program.

It is a privilege to be invited to say a few words about one phase of the research of our organization.

Before the advent of war we had some 55 people whose time was used for research, engineering and development, and were investing a much larger percent of our earnings in research than most industrial concerns.

As a result of our interest and study along these lines, we have come to realize that there are few "miracles" in science, but rather there are innumerable accomplishments that stem from the efforts of an almost infinite number of scientific investigations. The characteristic of our scientific age is not its miracles as such, but rather its greatly accelerated pace in observing the phenomena of our physical world, and thus permitting the rapid utilization of these findings to our needs.

The word "electronics", has become a present day cliche that advertising copy writers often use to describe the millenium that is at hand. We can greet this wishful thinking with a degree of hesitation, yet we cannot escape the premonition that we stand upon the threshold of a new scientific era that is going to be identified as the electronic age. Even at the present time, electronics has given us a new insight into fields that we had long felt had been exhausted. The field of sound is an example.

We had telephones, phonographs, talking motion pictures, radios, highly perfected mechanical musical instruments - we had just about everything that sound could offer us - that is everything we knew about at the time. Then we found there was a great deal more, but we didn't find this by listening to sounds. As a strict matter of fact, the new sounds that electronics opened to us cannot even be heard - they are higher in pitch than the highest pitched sounds our ears can perceive. It is no wonder

then that ultra-sonics, as they are called, so long elluded us.

Yet despite the fact that our investigations into ultra-sonics is still in what must be termed its infancy, we have become aware of some of the potentialities that are destined to convert this infant into a giant. Even now this child can do things more efficiently and more economically than many of its older brothers.

Our own research development has unfolded an electronic instrument that we have named the "Sonotest", a highly complex instrument which utilized ultra-sonic waves and will unerringly denote irregularities in 20 milimeter shells, such as loose rotating bands, and gross dimensional errors, cracks, and material defects - all these factors much more rapidly than any existing method.

The post war used will cover practically every field and ultra-sonics will play an important part in our social order. Their application will be utilized in the inspection of aircraft and automobile engines - this can be done much more accurately and quickly to minimize the hazard in faulty engines to avoid tie-ups of our transportation system.

In the mining industry it can be used as a detection instrument in possible dispersion of dangerous gas concentrations. It also has a possible use for geophysical prospecting in addition to electrical and seismographic surveys.

The above would apply equally to the great petroleum industry. In the field of chemistry, it has unlimited possibilities, in emulsification, floculation, saponification, precipitation, and the inspection of plastic products, purification of water and the softening of same.

In the packing, dairy and distillery field it can be utilized for control of bacteria and fermantation. Meat will be preserved and tenderized by use of ultra-sonic waves.

In agriculture we can visualize numerous mutations will be effected in plants and animals - possibly in the pollination or insemination stages. Also in the seedling and embyronic stages producing dwarf or giant species as desired.

It is now being used to prevent collisions of airplanes in the air and ships at sea - and is now known in that field as "RADAR".

Our own men predict we will be able to dissipate smoke and fog - it may even be used to induce rainfall during drouth.

We are looking to a post-war application where it can be commercially manufactured to install on automobiles so as you approach your garage you turn a switch and your garage doors are unlocked and opened.- as well as many other applications still too early to talk about.

If all of this is here now what, then, of the future? The future of ultra-sonics and electronics are one - together their accomplishments will be legion. They will provide us with new types of foods, new types of raw materials, new sets of medical techniques - as well as vastly improved versions of their present used. They will provide us again with an added appreciation of the fact there is another world beyond our limited sensory perception - we may even come to say - "truly my cup runneth over, because of the scunds I cannot hear!"

NOTE: Mr. Pierson demonstrated the instrument heretofore described by which direct sound waves, created by the mere tapping of two pieces of steel in his hand, turned on and off an electric fan at whatever position it might be placed in the room. The demonstration was exceedingly interesting to all those present.

Mr. Nichols inserted in the records a quotation from Collier's Magazine April 24, 1943, the following:

"In deep secrecy, the versatile electron is helping to win the war. Tomorrow you'll find it heating the house, minding the baby, preventing colds and making flying foolproof, to mention only a few of its jobs. It's going to have a profound effect on the postwar world."

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MR. NICHOLS: One of the things that I hope will come out of this conference is a more intimate relation between men engaged in private industrial research and our school research men. Tonight we will have about 150 men interested in research in private industry in and near Kansas City to meet with you gentlemen. I think it is a good opportunity for you to make contacts with them, because you never know which one of these firms may wish to put a fellowship in some of your schools.

Mr. Kettering, when he was here, said he would rather get a boy 20 years old, not over 22 at the maximum, to start him out on research because he wanted these young men without closed minds or opinions, and I am satisfied we have men of that caliber coming out of our schools in the west and I hope we will bring a closer contact and better acquaintance between you men leading the research in our schools with our local industrial research men.

We all recall the many new products which resulted from the first world war. Sad as war is, it does speed up research and from our present war, a whole host of new products will be developed and new horizons of industry will be opened. Let's be on our toes in the middle west.

Before we leave the geological discussion does anyone else here have anything to say particularly on that subject?

DR. CONDRA: I am the state geologist for Nebraska, and I am always glad to respond to any request of my friend, Nichols, and I would like to add one or two ideas to those already given.

In our state we have the same formations that Dr. Buehler and Dr. Frye spoke of. We do have out-croppings, all of which have been described in great detail but we have inaugurated something every state should have, that is to learn the composition of our land clear down to the granite. If you do not have a law in your state that requires the state to keep the records from all the deep wells and to study them and catalog them and put them in a library you have missed something. These deep wells have revealed resources at places where we did not know they existed. We have deep wells at certain places where we have found over 200 feet of good rock salt, where we have found several hundred feet of good gypsum, that is in the western part of our state and we find we have the same formations that are under the state of Kansas and down towards Carlsbad. We are analyzing that rock down to the granite to discover what may be below.

I ask our neighbors in Kansas when you get through deep salt that you look for potash. My suggestion to all you business men here with us, is that it is important in any part of the world to know conditions clear down to the granite and have an agency that will assemble information and make research on that very thing.

We have in Nebraska a very detailed geological survey and our purpose is not general publicity but to interest those people who want to develop it. We have most all these coal beds that Missouri has but they thin out

in Nebraska toward Omaha and other places. We are not recommending that anybody try to mine coal there; but we are glad that coal is adjacent in other states. It is too thin with us and we know it and we will not waste money trying to develop it. I visited a country where they gasify coal in thin beds and bring it into use and the time may come when the area from Missouri out to the west will bring this fuel up in another way.

I congratulate Missouri and Dr. Buehler, and Kansas and Dr. Frye, on the fact that they have had a long time program concerning these things that come up, and I am asking you men to really be pleased with the fact that there are groups of men spending their lives on determining the composition of the land clear down, whether they discover coal or potash or gypsum or salt or what not.

I hope you do not think I am breaking in as another state geologist, but my point is this, we have got to get the truth of the situation and not waste a lot of effort which will not have beneficial results.

DR. ROY CROSS: I think Mr. Nichols, and let me say I feel your conference is a fine move, Dr. Condra's suggestion that some of these companies get busy and find out about potash, is right to the point. Many of these oil companies have undoubtedly drilled through potash clear out through New Mexico, Kansas, Texas and Oklahoma and didn't know it. However, the phase of it, if I may invade the realm of geology, about which I know very little, I am impressed by the reports by Dr. Frye and others as to the tremendous amount of salt deposits in southern Kansas, Oklahoma, the Panhandle of Texas and Nebraska. I didn't know anything about that. If we add up the known salt, the salt that has been blocked out, the rock salt, I think it will figure close to two thousand billion tons of it. Now, where did that salt come from? It came from what the geologists call

the Permian Sea and extends from somewhere along in the Ozarks up in this area and on west, but the Rocky Mountain uplift came along and damned it up and made an area something like the Caspian Sea today, and that evaporated and made solid salt and there is a relation between salt in sea water and potash. That relation is about 40 to 1, so with a deposit of two thousand billion tons of ordinary rock salt there must be somewhere a deposit of one-fortieth of this two thousand billion tons or fifty billion tons of potassium chloride and if we follow it still further, for every one part of potash we have one-tenth of a part of grahamite, so there are five million tons of grahamite, and so on down. This Permian Sea has left an enormous wealth in this country, potassium, grahamite, iodite, magnesium, probably two hundred million tons of magnesium, and so on.

Following up this line of potash, the question is how are we going to find it. We have got to find it in the well holes. We have found down in New Mexico enough potash to take care of our immediate needs; they are producing around four hundred thousand tons a year I think and California produces a little, but still on the surface of the ground we are wasting potash. We are letting it run off to the Gulf of Mexico and the Atlantic Ocean, something like ten billion tons of potash a year and replacing not over a half million tons a year.

Potash is an important thing. We think in terms of other metals but life cannot exist without potash. The other day I saw a picture in Time Magazine of a lot of women rushing up to buy potatoes. I wonder if they really weren't rushing up to get potash, because 88 percent of the minerals of a potato is potash. It represents more than 50 percent of all the vegetables so it is pretty important but we get it and we don't know about it.

We talk about iron in our blood. It is a pretty important thing to have iron in your red corpuscles and you have anemia if you don't, and you can have a potash anemin, too. You need 40 percent potash and 16 percent iron, so potash is more important than iron.

Kenneth Spencer is figuring on using ammonia for fertilizer, but we have to have potash, too. Dr. Hale needs a little potash to grow cotton in Arkansas; you couldn't grow cotton if you didn't put potash in the fertilizer.

Now, after we find the potash how are we going to get it out cheaply? Down in New Mexico they sink a shaft one thousand feet and haul it out like coal. You can go down ten thousand feet, I believe, and mine potash by merely sending down an ordinary saturated brine, hot. Potash, as the temperature of your water goes up, its solubility goes up at a tremendous rate. Salt, however, in the presence of a saturated potassium chloride does not change temperature. Then what happens? You put a hot sodium chloride solution down in a hole one thousand or ten thousand feet and it will pick up your potash and then when you bring it out, cool it, your potassium chloride will separate. It is the cheapest mining in the world and potash can be mined more cheaply than ordinary salt. You do not have to have any shaft or anything, so if you find potash it can be mined at any depth and not only should you keep your cutting record but your circulating brine, your muds should be constantly analyzed every day, right on the ground to find out what you are going through.

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DR. CONDRA: I had the privilege of going through three quarters of a mile of the greaest potash mine in the world. The man who discovered that, discovered the potash where they were drilling for oil. He was the head

chemist in the Leningrad Institute in Russia. He told his people there were potash resources there and that there was a need for potash, not only for fertilizer, but for industry. They hardly believed him but afterwards they decided to prospect and they found potash and other things in association with salt. This man that I am just referring to was there to direct the men of the International Geological Congress and he told us that they had made a city of twenty-five thousand population, and that they planned it all the way through. They planned their city as to the streets and social centers and things of that kind before they made their mine. We are not for Sovietism but I believe that we should have our planning more comprehensive, learn the facts and do the job clear through. One of these days we are going to go deeper down in Western Nebraska and we will get there some new things and you will do it in Kansas and you will do it in Oklahoma, and in Missouri and in Arkansas, I believe. Those of us who are doing research must be looking forward to getting every last resource that we can that can be used for the development not only of local places but for our entire country.

Watch the next statement. Whenever a well is drilled in Nebraska, when they get their cuttings or samples, they never want any other company to know even the depth to which they are drilling until the test is finished but after it is done and all these samples are catalogued, they are put in what they call a library in which we have rooms full of information and anyone who comes along and wants to get it can go over these things, and get enough information so that he will not botch things up.

Let us find out what is down in under; let us develop according to the potentalities, let us get to the job. It takes a long time but we need the facts.

MR. NICHOLS: We will now hear from Dr. E. B. Branson, Professor of Geology on "The Greater Use of Calcium Rock or Alumina from Diaspore in Missouri and the Middle West".

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DR. BRANSON: I was happy to respond to the call of my old classmate, Clyde Nichols, at KU and my subject is, "Calcium in the Middle West".

Calcium was used for various things by man before he knew the element and to the present it has continued to be one of the highly useful elements. The Romans used cement made from volcanic ash and calcium oxide in building their great aqueducts and our most recent aqueducts are of Portland cement made from limestone the largest source of calcium.

This region imports much of its cement in spite of the fact that it has an inexhaustible supply of both limestone and shale which are the only ingredients needed for its manufacture. Coal, of course, must be used in its burning, unless gas is available, but the production of coal could be greatly increased in our region. A manufacturer picks his market and within a short distance of that market he can get the raw materials and coal and gas. Perhaps a better cement can be produced by research both on the raw materials and the manufacturing.

The same kinds of limestone that furnish the calcium for cement may be used for the manufacture of quick lime and for this also the supply of raw material is inexhaustable in this section. The pioneers burned their own lime merely making a kiln in the side of a hill, putting wood in the bottom and limestone on top and burning the wood. Many a farmer had his own lime kiln. The product was not as good as the lime made by modern methods but it served for all building mortar and also for plaster. The raw mat-

erials were the same as in this century and the number of kilns attest to the wide distribution of the raw materials.

One of the most extensive used of calcium in modern time is for fertilizer. The same kind of limestone as used for cement and lime may be pulverized and used on the land. The supply in this region is very large, enough to supply calcium to the soil for thousands of years. Almost every limestone quarry uses its finely pulverized limestone as fertilizer. Probably the region now supplies the entire demand for this type of calcium but the need will doubtless increase in the future. The lime for fertilizer in many places comes as a by-product of quarrying of limestone for building stone and road metal.

The calcium derived from gypsum finds its main use as an interior plaster. The Kansas City region must reach toward central Kansas for its gypsum. Gypsum is composed of calcium and sulphur and its change to Plaster of Paris requires processes about as complex as the manufacture of Portland cement. The Kansas region has a supply of gypsum sufficient to supply the Kansas City region for thousands of years, and the producers in the gypsum region seem to be manufacturing enough to supply the demand within their area of practical transportation.

Calcium lacks several qualities that have brought its closely related element magnesium into a prominent place since the war began.

Diaspore, one of the minerals composed of alumina and oxygen, as is bauxite, has been brought to the attention of scientists as a possible aluminum ore. In east central Missouri diaspore is present in many places but the quantity is not large enough to warrant the setting up of a large aluminum industry. Diaspore would be an expensive ore as it must be hand picked and sorted to get material of high enough quality for practical use.

It occurs only in scattered patches. More thorough prospecting might yield two or three times as much diaspore as is known but even that would be insufficient for large operations.

The aluminum from diaspore would be more expensive than from bauxite as it is much more resistant to reduction. The diaspore supply is being rather rapidly used up in the manufacture of refractories such as fire brick. The largest plant for the manufacture of fire brick in the United States is near the diaspore area in Missouri.

As a project for research the reduction of aluminum from plastic clays would be worth the time of some of our chemists. Large deposits of such plastic clays are present in east central Missouri within a possible Kansas City sphere of influence. It is rumored that a method of obtaining aluminum from such clays has already been discovered.

The writer had the pleasure of working in the chemistry laboratories at Oberlin College soon after Hall discovered the method of obtaining aluminum from bauxite, and that problem seemed just as difficult in Hall's time as the separation from plastic clays seems now.

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MR. NICHOLS: I think we want to be just as frank in discussing the things we do not have in sufficient amounts or which would not be practical, as in discussing the things that might prove desirable. God knows we have enough raw products in our area to support immense new industry. Let's guide and sell industrialists on the resources which we have and which they need.

I want it definitely understood this is not a Kansas City meeting - this is not a Chamber of Commerce meeting. They have been very helpful to cooperate with us but I say again the expense that has been involved in call-

ing this meeting together is being borne by several Kansas Citians and one or two outsiders simply in bringing you school men together, hoping something will come forth in forming a Mid-Western Research Council, and I am sure these men are sincere in their efforts to keep these things area-wide and not just for Kansas City. Kansas City happened to be centrally located but this is an area meeting and it is not a Kansas City meeting and I want all you men to realize that.

Dr. Robert H. Dott of the Geological Survey of Oklahoma will speak on "Oklahoma's Industrial Minerals".

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DR. DOTT: Gentlemen, I was glad to accept Mr. Nichols' invitation. My subject is "Mineral Resources of Oklahoma" and I have limited that to Oklahoma industrial minerals of which we have ten which we consider of prime importance because of their quantity, their quality or the fact that they are already well established as producing industries. The ten that I would list are first petroleum, natural gas, coal. I am not going to discuss those because they will be discussed later. Then we have dolomite, limestone, gypsum, zinc and lead, volcanic ash, bentonite and we have at least fifty minor minerals of which I selected a few to which to give slight mention. Taking up oil field brines first, throughout the oil fields of the state, of course large quantities of salt water are produced with a well. At the present time that is a dead expense to the operators and has been a headache ever since the industry started. We have analyses of a few of the brines, and among those analyses are a considerable number that average between two and six thousand parts per million of magnesium. In many of the more recently developed oil fields they have very modern disposal plants in which the salt water is disposed into producing formation. In

some of the plants it is given treatment such as aeration to get out the iron and other sedimentations, and we believe an enterprising producer could install a plant to extract from the brine the magnesium and return the balance of the salt water to the sub-surface formation without any difficulty whatsoever. In other words there is a resource you can get for nothing. The cost of the plant has to be considered but the actual lifting of the water could be delivered at the plant without any cost and the method suggested is the one in use at Freeport, Texas, for taking magnesium from sea water. We could go a little further and use the dolomite, and extract magnesium both from the salt water and the dolomite.

There is a good market in this area from refractories which could be made from the magnesium oxide. In addition, if there are good markets for it, calcium chloride and other salts could be recovered but our idea on the brines at the present time, everything considered, is that the magnesium is the thing which would offer the most possibilities.

In dolomite, we have very large deposits, one in the Arbuckle Mountains which has a total thickness of 700 feet. Our sampling has not been intensive at all, but it is fairly representative and it shows it to be theoretically pure dolomite, and one out-crop is about 700 feet thick by about a mile wide and 10 miles along. There are others in other parts of the state equally good but not as large as that.

I might mention refractories for dolomite, using them for treating brines and the paper mills. One other possibility I want to mention is the use of dolomite by the ferro-silicon process. This was put into production about a year ago and is similar to the smelting of the zinc; the equipment is about the same. The only difficulty is that in this area we have no ferrosilica. It could be produced in some areas where we have economical electric power.

I think we all realize magnesium is bound to be a very important thing following the war, and it is a thing we feel is entitled to considerable consideration.

As to limestone, we have three or four series of deposits better than 99 percent carbonate. Some of them have a little magnesium with them but others are pure calcium carbonate, 99 percent plus. We did have a very fine lime industry which has grown up in the last few years, and the Oklahoma Geological Survey has done a good deal to keep this firm in business by helping them expand and helping them locate one deposit which just met their needs. We believe that some of that stone will be used for fluxing purposes.

We have two cement plants, one of which recovers carbon dioxide as a by-product which makes all the dry ice that at least Oklahoma can use.

A few years ago the geological survey did some research on the production of rock wool from Oklahoma materials and we found that almost anywhere in the state there is material suitable for making rock wool. One plant is in operation in Tulsa.

Glass sands of high purity are found particularly in the Arbuckle Mountains, but they are not restricted to that one area; they are located in two or three other parts of the state and are being produced in rather large quantities in the Arbuckle Mountains. It is very high grade sand but the grains are a little bit smaller than the glass people like. We know of some other deposits that are not nearly so thick as the ones being used with a considerably larger grain size and we hope to do some investigation on that. We have glass plants in the state making plate glass, window

glass, food containers of all kinds; one plant now shut down made gasoline pump cylinders, and as a by-product, five gallon glass bottles, and another house makes all sorts of novelty products such as mail boxes and drawer pulls and that sort of thing.

Gypsum, in total tonnage, is our largest resource. Somebody once made an estimate of over one hundred million tons of gypsum in Oklahoma alone. We have one large mill operating and several small producers serving cement plants and so forth. Oklahoma has lead and I believe still leads the nation in the production of zinc.

Last on my list of the really abundant resources of Oklahoma is volcanic ash and meta bentonite. I do not think we can compete with Kansas in the amount of volcanic ash but we have got quite a supply. Unfortunately, for us, Kansas is closer to the markets than Oklahoma has been, so volcanic ash has not gotten much of a play. However, there are other uses for it besides scouring powders and we think research along that line might be fruitful. Meta bentonite is a good material for bleaching lubricating oils. That is just a possibility, if you get around to use it.

Among the minor minerals are iron ore of which we estimate about a half million tons scattered in small deposits, a very small deposit of manganese, a pretty good grade, however, asphalt, asphaltic oils and grahamite. Asphaltic oils are being produced and used for road oil in a number of areas but we constantly get inquiries for additional deposits or locations. We do not have a great amount of it but we do have some.

In the eastern part of the state we have several deposits of grahamite; that is a hard oxidized petroleum residue which at the present time is not being worked but which has some possibilities. I think in the past it was used for carbon black to a small extent at least, and it has been

used as a dryer for the asphalt filling of concrete expansion joints, and is used in paints and a number of other ways but at the present time it is not being developed.

We also know, although we do not have the information we need, that certain of the oil field brines have considerable strontium and barium and we have one small district with a very small deposit of celestite phosphate.

In the Wichita Mountain area we have a rather healthy granite industry until the war came along and took all of our help and materials, but Oklahoma granite is coming to be recognized as one of the coming resources of the country. In south central Oklahoma we have some granite which was of the pegmatitic type or feldspar. We think perhaps the feldspar could be separated and furnished to the glass plants in our region.

The state has an abundance of brick clay, a fairly large brick and tile industry and a few clays are known to be suitable for making pottery. In fact, we did have one small pottery concern making art ware from a clay near the Arbuckle Mountains. In the Wichita Mountains we have a kaolinite type of clay which we are studying now which may have some possibilities as a refractory, or if the production of aluminum from the low grade clays is ever made feasible, we believe we may have a very large deposit which might have some possibilities.

In the northeast portion of the state we produce tripoli and it is shipped over into Missouri and processed.

I could go on and list a number of others, but I believe these are the ones that we are most interested in.

MR. NICHOLS: Some of these days we may build houses from glass - glass insulation is already here - produced right in our area. Then too,

why not pottery and all the ceramics right here in the middle west where we have cheap fuel? Dr. Dott, your paper was excellent.

MR. NICHOLS: I ask Dean J. J. Jakosky to tell us something about the geophysical methods of determining resources in the Middle West.

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DR. JAKOSKY: My subject is The Use of Geophysical Methods for State-wide Studies, but before I read my paper, I wish to say our whole area is indebted to Mr. Nichols for bringing us together.

A thorough knowledge of the raw materials in an area is the foundation upon which basic plans for industrialization are built. The first step in the development of any raw material is its discovery. The second step is its economic evaluation. The evaluation considers the extent, (the areal distribution and thickness) the richness (value per cubic feet or other measurable quantity), and the uses and markets for the material.

The third step is the exploitation of the product. This step is concerned with the financing, promotion and the engineering problems of recovery of the material.

This paper is concerned chiefly with the first and second steps, that is the location and the economic evaluation of raw material deposits that exist in an area.

The present and most widely-used technique of a planned exploration comprises two steps, (a) geological or prospecting studies and (b) direct exploration by means of drilling, excavating, shaft, tunnel or pit operations. This technique allows samples to be collected from which assays or other analysis can be made. The recovery of direct samples is most

important as it allows a quantitative evaluation of the deposit. There are certain disadvantages to such direct exploration, chief of which may be mentioned (a) the time factor and the cost, and (b) right-of-way and trespass privileges. Even the most rapid method of exploration, the drill, may require days for penetrating the overlying strata to reach the desired deposit. The time and cost of such work is oftentimes, prohibitive, where general reconnaissance is being done. Oftentimes difficulties are encountered in securing proper right-of-way or trespass privileges. Especially is this true in areas where cultivated land or improved property must be trespassed, etc.

Both of these drawbacks hinder exploration over large areas, such as studies by a State to develop its own state resources. However, it has been found during the past few years that a proper combination of drilling or other direct exploration and the somewhat more indirect geophysical exploratory methods offer a very low-cost exploratory technique by means of which large areas may be studied economically and rapidly, and whereby actual samples can be taken as required.

The words, "proper combination" as used in the preceding sentence refer to a geophysical survey utilizing sufficient direct exploratory methods to furnish the necessary control. The amount of this control will depend, of course, upon geological conditions and the relative physical properties of the materials comprising the subsurface.

Geophysical exploration methods involve the making of certain physical measurements at a series of points on the surface of the earth, and then deducting from these measurements the probable composition and configuration of the subsurface. Such methods of exploration are cheaper than the direct exploration methods, but like all diagnostic methods, they need

proper control to give the necessary accuracy and reliability.

The use of combined geophysical and direct exploratory methods is not new. In practically all cases, the combined technique has yielded results that are more reliable than can be obtained by geophysical methods alone, yet cheaper and more rapid than can be obtained by the use of only the direct exploratory methods. The combined technique has been slow in adoption probably due to the wide divergence of view points between the exponents of direct drilling exploration and of geophysical exploration. As a rule, the direct drilling exponents have little use for the predominating mathematical interpretations and techniques of the geophysical methods, and do not like the type of answer that appears to be related to a scientific form of crystal gazing and which must be qualified as a "probable" subsurface condition. There is "no guessing" when a drill penetrates a deposit and a core recovered. Oftentimes, however, the drill may miss a deposit by only a few inches and the very positiveness of the method may give the wrong answer. The geophysicist, on the other hand, sees little need for spending the relatively large amounts of money required for direct exploration, and is usually impatient of the time and trespass problems involved. Socially, another difference operates to minimize use of the combined technique. A preponderant number of the direct exploration exponents are "practical" men, while a majority of the geophysicists are of the "theroretical" type. Unless direct efforts are made, these two types are seldom found together on a single field crew.

An illustration of the combined technique is the recent exploration in the Tri-State area of Missouri, Kansas and Oklahoma. This is the most important zinc producing area in the world. Considerable

previous work has been done by various investigators, and special reference should be made to the work by Professor Buehler who has conducted magnetic studies over a considerable portion of the Missouri zinc producing area. Our recent work in that area indicated that the resistivity and the gravimetric geophysical methods could be combined successfully with the drill. These geophysical methods map the contours of the limestone, which underlies the shale in that area. In addition, certain structural and lithologic features associated with ore mineralization, especially decreased porosity of the limestone resulting from fracturing and brecciation, could be mapped. Previous history of ore occurrence in the district shows that the ore occurs chiefly in such brecciated or fractured zones. Geophysical methods were employed to locate the type of anomaly that would be associated with the brecciated zones. This work was then followed by actual drilling to determine the nature of the "geophysical anomaly". Exploration was done at a cost much less than that of the present conventional direct-drilling methods. It was found that geophysical work of a most detailed nature over ten to twenty acres, could be done at a cost of less than that of one drill hole. Due to the localized nature, (small horizontal extent) of the ore pockets in that area, one drill hole has been found to have an effective exploratory value with a radius of less than fifty to one-hundred feet. The combination technique therefore, may be applied at a cost of about one-twentieth of the direct drilling method.

Another illustration of the combined exploration technique is obtained from studies made a few years ago in the Lompoc Valley of California. In that area, it was necessary to study the infiltration of seawater into the gravels comprising the Santa Maria River Valley.

By use of existing water wells, and a few specially located drill holes, it was possible to accurately correlate the change in resistivity over the entire valley area with changes in salinity or "brackishness" of the water. The cost of drilling the necessary holes to obtain comparable information over the valley area would have been prohibitive. In addition, time and trespass limitations would have prevented such studies.

Another interesting application of the combined technique is the subsurface studies made at the T. V. A. project on the Clinch River in Tennessee. The U. S. Army Engineers had selected three sites as being suitable locations for a dam. Geophysical studies over these three sites disclosed that all of the sites had cavernous limestone in the bedrock. At one site, however, where the present Wilson Dam is located, cavernous bedrock conditions existed over only a portion of the East bank. During the exploratory studies of the sites, control drill holes were located from 200 to 1,000 feet apart along the traverse lines. The subsurface conditions between the drill holes was explored by means of geo-electrical methods. The combined technique is estimated to have been done at a cost of approximately one-fourth that of direct drilling methods, and in less than one-tenth the time.

It appears that this combined geophysical and direct exploration technique could be successfully utilized to determine the position of shallow water tables and the resultant effects upon important crops such as alfalfa. As an illustration, the Meade basin in Meade County, Kansas, was in the latter part of the previous century, and the first few years of the 20th century, an extremely important alfalfa growing district. In fact, for a period of years it ranked second in the counties of Kansas

and supported several alfalfa mills in the town of Fowler. At the present time and during the past twenty years, alfalfa has been a crop of very minor importance in this area, and can be grown successfully only under irrigation. It appears that this decline in the production of alfalfa is directly related to the unique conditions of ground water in the area. As is explained in the Geological Survey Bullentin by Dr. J. C. Frye, this area is underlain by two types of ground water; (1) artesian water encountered in Pliocene and Pleistocene deposits at depths normally ranging from 150 to 300 feet, and (2) non-artesian ground water occuring in the unconsolidated silts and very fine sands underlying the floor of the basin to a depth of about 100 feet. Based on the best evidence that we have been able to obtain, the water level in those shallow deposits was, during the period of extensive alfalfa growing, about 10-12 feet below the surface. Alfalfa is a very prolific user of ground water and apparently the long period of extensive growing virtually de-watered this shallow material and depressed the water level to a depth of 30 or 35 feet or more below the surface. Geophysical studies and a few well-placed drill holes could easily tell what has happened to the ground water supply. Such studies would also supply interesting data as to whether the ground water supply is being replenished during the present wet cycle. Upon such data could be based predictions regarding the future alfalfa-growing possibilities of that area.

An interesting application of this type of exploration technique appears to lie in the soil sciences. In studies of this type, geochemical methods can be utilized to study the areal distribution of the various elements and salts in the surface of the ground. Certain

"trace" or "micro" elements in the soil have a very important bearing on the growth and health of plants and animals. Due to the minute amount of these elements present in the soil, ordinary chemical methods of analysis are not, in general, applicable because they are designed to analyze for larger quantities. In recent years, a new field of geochemistry has been developed which deals with analysis of exceedingly small quantities of elements, and can give quantitative results accurate to one part in a billion. The methods of analysis are well developed, as is also the technique of securing field samples. Generally speaking, these techniques comprise the collection of samples taken systematically over the are followed by laboratory spectrographic or chemical anlaysis.

It is now known that deficient soil mineralization has a most important bearing on the mineral content of plants and produce grown in an area, which in turn has a direct bearing on the human dietary deficiencies. Carious teeth, the entire absence of teeth, the absence of front teeth, the absence of molars, and malocclusions, all give evidence of poor tooth structure, which in turn is due, for most part, to inadequate diet. It is further believed that such inadequate diet is caused by a lack of the necessary calcium and phosphorous in the soil. In addition, anemia, low hemoglobin, low vitality and energy are all directly related to the lack of proper minerals in the soil. It appears that much intelligent planning could be done by proper soil reconditioning, especially by use of fertilizers to remedy these soil deficiencies.

Some progress has already been made in studying areas deficient in magenese, calcium, phosphorous, and zinc. The effects of the lack of these elements on certain plants growing in these areas has been recognized, but it is only recently that the lack of these elements on animal or human nutrition has been studied. A more complete understanding of

this problem requires that more extensive studies be made of the areal distribution of these soil minerals. In addition, we need detailed and long-time studies on the effects of a wide variety of soil treatments on the full chemical composition on plants growing on various soils, and the effect of the consumption of such plants on human beings and animals in the area.

In conclusion it is hoped that the states of this area will effectively correlate their technical staffs with the "practical" field operations to supply the extended data so necessary for proper industrial development and health of this area.

MR. NICHOLS: That was an extremely interesting paper and certainly of value in exploring the resources of our area.

DR. BUEHLER: When I stand up to the same audience as Dr. Jakosky, I feel very humble on the subject of geophysics. He is known as one of the experts in the United States. However, I would like to call your attention to two maps that I have over here on the wall - the State of Missouri, in which we have cover d the entire state with magnetic research, and the entire state with geometric research. We feel that these geophysical methods can be used in connection with our direct prospecting, as Dr. Jakosky has just outlined, and we feel we have entered in a rather profitable method of prospecting by our geophysical work and instead of stopping it I think we will expand it, if we can get the money.

(An adjournment was here taken for lunch which was served complimentary to the "School Men" and which many local research men attended)

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2.00 P. M. Monday, June 7, 1943

MR. NICHOLS: Let us carry on for our grand Middle-West and we will hear from Dr. A. L. Burwell, of the Oklahoma Geological Survey.

DR. BURWELL: I am going to talk on coal, and, Mr. Nichols, we are indebted to you for this meeting. As early as 1891, the annual bituminous coal production in the State of Oklahoma has reached the million ton mark. Ten years later it was over two million tons. In another two years it had reached three million, and by 1920 (the peak year) it was close to five million tons. Compare the foregoing figures with the 1939 production of one million, one hundred seventy-eight thousand tons and you will observe that we are back to the 1891 status. What was it that very nearly put Oklahoma coal out of business? The "softening blows" were delivered by labor disputes and strikes. The "knockout punch" came through competition with petroleum. Production is now on the gain, due to war demands, but can we hold these gains after the war?

Up to 1940, one hundred thirty-five million tons of coal from Oklahoma mines had been produced and consumed. There remains an estimated known reserve of 55,000,000,000 tons. That represents a lot of wealth even computed on the 1939 average value of $2.44 per ton, (this figure includes selling cost), but it is nothing compared to the total real wealth that may be derived through chemical utilization of the coal in industry.

The coal fields of Oklahoma are found in the east-central and northeastern parts of the state. The workable coal underlies an area of approximately 12,000 square miles in Atoka, Coal, Craig, Haskell, Latimer, LeFlore, Muskogee, Okmulgee, Pittsburg, Rogers, Tulsa and Wagoner counties. The type of mining varies from shaft and slopes to stripping, depending upon local occurrences, with obvious differences in cost of mining.

Analyses on these coals show wide variations. There are low-volatile

medium volatile coals
coals/ and high-volatile rank A, B and C coals. The sulphur content ranges from a low of 0.5 percent to as high as 5.5 percent. Ash content is as low as 3.4 percent and as high as 13.0 percent. The softening point on ash has been determined in many instances. The majority of tests gave low temperature softening in Class III, with a few in Class II.

Oklahoma coal has been utilized largely as a steaming coal. No beneficiation of the coal is practiced. Other uses will be made, we know, of certain coals. Through the foresight of the Director of the Oklahoma Geological Survey, Mr. Robert H. Dott, a cooperative investigation with the U. S. Bureau of Mines on the coking possibilities of Oklahoma coals was started in 1940, which proved that certain Oklahoma coals can be processed to acceptable metallurgical coke, - not any one coal by itself, but by blending two coals of proper composition and in proper proportions. Here you see the results of applied research, leading to processing of raw materials with enhancement of values. Without this research - without metallurgical coke from nearby Oklahoma coals, the blast furnaces and steel plants for northeastern Texas would hardly be economically feasible.

This little research just barely scratched the surface. Only three Oklahoma coals were investigated; a low-volatile Hartshorne coal from LeFlore county, a high-volatile B rank coal from Henryetta, and a high-volatile A rank coal from the McAlester seam.

Coke from the high-volatile coals was small sized and highly fissured, with corresponding low indexes on both shatter and tumbler tests. The coke was far from satisfactory. Fortunately, however, blending with low-volatile coal from an adjacent district produced a very satisfactory metallurgical grade coke. The extent to which low-volatile coal may be used in a blend will be determined by the expansion properties of such blends. The

expansion properties must be determined before carbonization is attempted in by-product ovens, or serious damage to the ovens may result.

By-products obtained during the coking tests indicate that in comparison with standard eastern coking coals, the yields from Oklahoma coals are higher on ammonia, light oils, and gas but are lower on coke and tar. However, the tar-acid content of tar from Oklahoma coals was high (13.5 percent) and nearly twice that from the eastern standard. The light-oil contained 5.2 percent paraffins (which is high) and may make the refining of benzene and toluene difficult. However, higher coking temperatures may reduce the paraffin content.

Further research is advisable. In fact, further research is essential if maximum returns are to be had from utilization of Oklahoma coal. Other coals should be subjected to coking tests. The softening point on ash should be checked. The softening point is not important on metallurgical coke but it is a determining factor on coal or coke for gas producers and on coke for domestic and industrial uses.

Information on the expansion and contraction properties of all coal should be obtained. More must be known on the susceptability of Oklahoma coals to oxidation under storage, because oxidation may, within a short time, cause deterioration in coking qualities to a point where the coal is worthless for that purpose. Sulfonation of Oklahoma coals should be studied. Sulfonated coal is used as an ion exchange material in rapidly increasing amounts, in water conditioning and in several industrial processes. The ion exchange value on any sulfonated coal can not be forecast. Direct experimentation is necessary. Macroscopic and microscopic examination of Oklahoma coal is necessary, too, in order that the occurrence and proportions of vitrain, clarian, durain, and fusain may be known. This

will be of great importance on any research on the hydrogenation of this coal, a subject which may transcend all cthers if new petroleum reserves are not found.

If full benefits are to be derived from possession and utilization of natural resources -- coal among others - we must know these materials intimately, their properties, variations, adaptability, availability, their weak points as well as the strong. Therefore, research and experimentation must come before commercial exploitation. It may be perfectly all right to say of American industry that "difficult problems are solved immediately - the impossible ones take a little longer", but when confronted with a problem the solution of which depends upon adequate technical information. Industry wants that information now, not tomorrow, next month or next year.

MR. NICHOLS: The Lord only knows how many products can be made from coal - Sulfa drugs are a good example. I ask Dr. Costonguey, head of the Research Department of the Kansas University to talk on the greater industrial utilization of salt.

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DR. COSTONGUEY: First, let me thank Mr. Nichols for calling this conference. There is a tremendous amount of salt in Kansas and northern Oklahoma. In the United States Geological Survey Bulletin 669 "Salt Resources of the United States", Mr. Phalen points out the three most important single salt deposits in the United States, first the large bed that extends more or less continuously under western New York, southwestern Ontario, northern Ohio, and most of Michigan; the second important location is the salt producing area found in West Virginia and southeastern Ohio, and the third, in which I am interested particularly, is the large deposit of rock salt in central Kansas and northern Oklahoma.

About nine million tons of salt are produced annually in the United States. If we would go back to the figures of 1939 or 1940, of this nine million tons which is produced in the United States we would find Michigan producing about 26 percent, New York, probably about 22 percent and Ohio around 19 percent. That means that the remainder of the salt was produced largely in Louisiana, California, Texas, Kansas and part of Oklahoma, perhaps. In Bulletin 41, put out by the Geological Survey of the University of Kansas for 1942, on page 149 the present production of salt in Kansas was put at about seven hundred thousand tons annually and they estimate a reserve of about five thousand billion tons. That is not a great deal of salt being consumed as far as Kansas or Oklahoma is concerned.

Now, I was thinking, with such a large deposit of salt in our area, perhaps other uses than for the table or dairy uses, canning and the packing industry might be developed. If we stop for a few minutes we realize that it is the basic material for the important industry making sodium carbonate, soda ash and sodium hydroxide, caustic soda, which are vital to the industries of pulp and paper, glass and soap. You might be interested in the fact that in soap manufacture they consume about 8 percent of the sodium hydrox consumed. From salt, also, is obtained chlorine, 455.000 tons were produced in 1940, which is used in the pulp and paper industry, the textile industry, the manufacture of organic chemicals, and in water purification.

We are not certain yet, and I want that brought out, we have not made up our minds one way or the other, we are just getting these facts together, whether it is economically feasible to produce electrolytic chlorine and sodium hydroxide, caustic soda, by utilizing the salt deposits in this area. That takes more study than a fast survey like this would make up, but there is that possibility.

If we stop to look at the geographical locations of plants producing electrolytic chlorine and caustic soda, we find them on the west coast, California and Washington, on the Gulf Coast of Corpus Christi, Texas and Baton Rouge, Louisiana, and the closest plant here in this area is in St. Louis, Missouri. The remainder are located from Michigan more eastward so that leaves a tremendous area where there is very little, as far as I have been able to find out, of any production of caustic soda or chlorine by any electrolytic process.

The products that could be manufactured by a plant under consideration in this area would be caustic soda, chlorine, hydrogen, and muriatic acid. I think there is a market for these products at present in this section. The market for the muriatic acid is presented by the oil production industry in the acid treatment for oil wells. The consumption of muriatic acid in the state of Kansas amounts to approximately 1,200,000 gallons of 18 degree Baume acid per year. If you were to produce this acid it would cost perhaps one-hundred fourteen thousand dollars. The shipping cost of this acid calculated from the closest point of manufacture, Monsanto Chemical Company, St. Louis, Missouri, to a centralized section of Kansas, namely Raymond, Kansas, is approximately $60,000.

Caustic soda is used in the manufacture of soap and there are two large soap companies in Kansas, and in this state; I don't know about Oklahoma and the surrounding states yet, and it might be possible that the electrolytic caustic could be sold to these companies cheaper than it could be produced in the soda ash process.

In the color treating of oils, caustic soda is used for neutralization operations and there are 23 refineries in the state with an estimated capacity of 210 thousand barrels per day of crude. I have simply based this on the amount of muriatic acid that was used in the State of Kansas to

give me some idea so I could figure out and do a little bit of thinking first. In the production of the required amount of muriatic acid used in the state, there would be produced an equivalent amount of 1654 tons of 76 percent caustic per year. The shipping cost calculated from the nearest point of manufacture, Monsanto Chemical Company, St. Louis to Raymond, Kansas, amounts to approximately $25,000 per year. The cost of caustic soda is $92,700 and the purchasing cost of acid and caustic is $207,000. Approximately 3,300 tons of salt would be used per year.

The market for chlorine is in its use for water treatment, manufacture of antiseptics and anesthetics and chlorination of hydro-carbons. The amount of chlorine for treating water in the State of Kansas amounts to 1500 pounds per day.

Experimental work now being carried on with the hydrogenation of hydrocarbons and the preparation of NH, may provide a demand for hydrogen gas.

We may not be justified in proposing the building of a plant with the muriatic acid consumption in Kansas as the basis of calculation, but should Oklahoma and other neighboring states be taken into consideration, the construction of such a plant might be an economic feasibility. Dr. L. D. Vorce of the Westvaco Chlorine Products Company, stated that the cost of an electrolytic chloring plant manufacturing chlorine and caustic soda could be estimated at $50,000 to $60,000 per ton of caustic capacity.

This proposed plant, as I figured out from the amount of muriatic acid used in Kansas, would be only about a 5 ton of chlorine capacity per day and it is probably not economically feasible in this section unless we could get other states to be interested so that would be approximately an investment of $300,000 or something of that nature, but I think, I do

not yet know the answer, because I can only base it on facts when I get them, is that it might be economically feasible to have such a plant in Kansas or Oklahoma, wherever the best salt beds appear to be. I cannot get those analyses, so I do not know just exactly at the present time where the best salt is located. It might be at Hutchinson or Reno or again it might get down into Oklahoma but I think there is a possibility there.

MR. NICHOLS: Doctor, what were the economic reasons back of the closing down of that plant out at Hutchinson a year ago, do you know?

DR. COSTONGUEY: No, I haven't been able to find out. I have been out there trying to get that information but I can't get it yet.

DR. REID: It was an obsolete plant, for one reason, high cost of production.

MR. NICHOLS: I wonder if there is some economic reason why so many of the plants should be up in Michigan? You have not reached a conclusio yet whether you could recommend that we could compete with them or not?

DR. COSTONGUEY: No, I haven't reached that conclusion; that would take a little more study.

DR. LEWIS: How do the salts compare with Michigan salts in magnes and bromium?

DR. COSTONGUEY: As far as I have been able to ascertain from some of the analyses that come in, the amounts of magnesium and magnesium bromium in Kansas salt are comparatively low, I mean lower than they are in the Michigan brine. I haven't a complete analysis of Kansas salt. I have been trying to get that from the Geological Survey.

DR. LEWIS: Of course, that is better for a table salt and many other purposes and I don't know how the industry is enhanced by having magnesium.

MR. CHARLES THOMPSON: This is a project that we have worked on for about 8 or 10 years and I have a good many of the facts available if the gentlemen want to know about it. The disastrous experience of attempting a soda ash plant at Hutchinson I won't review. We were the agents for them when they first started and we sold soda ash for as low as 35 cents a hundred for several years and the local owners got discouraged and sold out to Solvay, because they used their tremendous production to equalize the freight rate.

You must remember that your freight rate is no barrier because all the plants equalized the rate, and that goes for not only this plant but all others.

The reason for the non-economic condition is you have no industriak consumption except for instance the chlorine. You spoke of one plant at St. Louis. There is a plant at Tulsa, the Ozark Chemical Company which produces muriatic acid in substantial quantities at Tulsa. There was also an effort made in Tulsa where two and one-half million dollars was spent in using salt by the Texaco Salt Production Company and again you had the unwillingness on the part of the established factories to allow that institution to live and they absorbed the freight rates and in fact sold lower in that particular area until they put them out of business.

At the present time the reason an alkali plant is not a justifiable economic proposition is the fact that your oil industry has a diminishing use for caustic soda instead of an increased use. The oil industry is eliminating the use of caustic soda and are tending to the solvent process. You have here in Kansas City two large users, two soap industries, Proctor

& Gamble and Peet Bros. and you have no other soap industries anywhere in the area. These soap industries may have plants in other parts of the country and they make a nation-wide contract; they cannot isolate these two plants from their total picture. If they get low cost soda ash from Hutchinson, which they used to do, they are penalized on the east coast because the proposition generally follows "you either give us your Kansas City business or we won't give you a decent price on your other areas".

The cost of a chlorine caustic soda plant is infinitely less today than it ever was before. You can put up even a ten or twenty unit cell plant for not to exceed one hundred to one hundred fifty thousand dollars today but you cannot get an even distribution of your products. As you make caustic soda you get a surplus of chlorine and you haven't a market outlet to take it all in this area. There are no big consuming outlets and the end point is that the big boys who look over these fields very carefully find they can increase their production at units already established cheaper than they can build a plant here and there are some cells in your salt that they have not solved the difficulty of yet.

I don't know whether that is too generalized or not but I just wanted you to have those facts.

DR. BREWSTER: Mr. Nichols, isn't this where research in the matter comes in? I had a proposition for the use of chlorine and was turned down because there was no chlorine available. We hold down the use of chlorine because there is none available. Maybe by starting these things we could make both things fit together.

DR. CONDRA: You made that statement about Michigan. Isn't the other item that gives Michigan production, their protection?

DR. COSTONGUEY: The big item they have there is protection. Some of those wells up there are producing not too high a grade of salt but they are protected. The Wyandotte Salt Company are seeing to the protection.

What appeals to me is the cheapness of power in this area. I do not know exactly how much it would cost to make electricity from your natural gas; I haven't the figures on it but I have checked it with people in this vicinity that I know handle the natural gas and I don't know whether you could buy it for 4 cents or 6 1/2 cents per one thousand b.t.u's, but that could be worked out.

MR. THOMPSON: It is available at 6 to 6-1/2 cents and you produce current for about three mills.

DR. COSTONGUEY: I would like to have this threshed out because I don't want to put a lot of time in on something that some of your people already have locked up in your heads.

MR. THOMPSON: I am here at your invitation, Mr. Nichols, and I wish to say it is a practical objective if you want to undertake 10 years of hard work and no money, because it is more than the economic developments. You have got factors in here that are not going to let an establishment of that kind survive without heroic effort. It is established interests like Solvay and people like that who are already covering that area that are not going to lose that tonnage without a fight.

MR. NICHOLS: If we get more industrialization of this area it might create more market.

MR. THOMPSON: One factory was started ... at Corpus Christi and it brought three other factories there over night and there is not enough production for one to operate. Solvay is at Baton Rogue and Columbian

Alkali Company at Corpus Christi.

MR. NICHOLS: I still feel we are not scratching the surface in using our salt deposits and Mr. Kettering felt the same as I do. If there is no other discussion on this subject I am going to call on Kenneth Spencer.

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MR. SPENCER: I notice the figures here on coal have to do with the reserve of coal in the Middle West, cited at 55 billion tons. That includes sites of coal as thin as 16 inches down to a depth of something over 15 hundred feet. There are tremendous reserves of coal in the Middle West, but the tonnage which can be mined at the present price of coal is substantially less than that. I mean the coal reserves at the present prices, assuming we do not have inflation and everything else, each and every factor is relative, there are many years of coal reserve but I am always shocked at that 55 billion tons because it includes coal that we would not attempt to mine at present day prices.

I noticed another reference here to the problem of research in the development of coking, expanding coals as a factor which is typical of the high volatile coals of the Middle West. There is a definite answer to that. There has been developed a horizontal coke oven with a flat arch that permits coke to expand at will without damage to the refractory and it is less expensive than the shop type coke oven. I think the coking of coal, of course, is one of the steps which does permit the recovery of by-products, and in that connection there is an important factor that has come about and that is almost the elimination of coal tar as a by-product, due to the splendid job the petroleum industry has done in petroleum development.

I just make that observation that these western types of coal can be successfully coked and they have been coked and there are plenty of western coals including the Oklahoma, Kansas and Arkansas coals that will make metallurgic coke for the new steel industry that is being developed in Texas, so there is one technical problem I think we are over, and that is the matter of handling and expanding coke.

DR. BURWELL: It isn't entirely a question of expansion; our coal in Oklahoma is very high in sulphur. There is less sulphur in the McAlester system but when you take the low volatile, which is necessary to blend with that McAlester coal, then you are handling something with high sulphur.

MR. NICHOLS: We have at least enough coal to support a big plastic industry, haven't we?

MR. SPENCER: Yes, we aren't going to run out of coal for a long while.

DR. BURWELL: The production of tar acid in Oklahoma coal is 13-1/2 percent, that is about twice what they get from the Standard Pennsylvania coal; therefore we are sitting pretty as far as tar acid is concerned and which has great potentialities.

DR. HECKERT: The tar acids in the Pittsburg coal are considerably higher than the tar acids that you get from the Illinois coal or from some of the Pennsylvania coals. The tar acids amount to around 25 percent of the distillable tar, that is after you take the pitch out of it; that is, your tar distillate contains 25 percent tar acid and that tar acid is such that makes it extremely desirable for plastic or wood impregnation.

MR. NICHOLS: There are certainly a lot of things coming out of coal today in connection with plastics and no one knows how many new items research will find.

MR. THOMPSON: But they are going more to oil.

DR. ROY CROSS: I wish you would tell us something about the possibilities of low temperature of distillation of coal.

MR. SPENCER: I am not prepared to discuss the chemistry of it. I do know there have been a lot of figures made on the distillation of coal, thinking it is a step in picking up the source for internal combustion engine motor fuel and the best estimates I have ever seen talk about the cost of motor fuel of an octane content that would be usable of 12 to 14 cents a gallon which of course is entirely out of line today. We know that in Europe that is a common source of motor fuel and may be it isn't too early to be putting in complete distillation plants for either high or low temperature for the recovery of motor fuel and lubricating oils from coal.

It certainly would not be a profitable undertaking at this time but Secretary Ickes has recommended and publicly announced in the last 3 weeks that the process which the Bureau of Mines has developed should be placed in a chemical test, frankly admitting that it would not be economical today but what you learn in the operation of a test plant, in view of the declining discovery of petroleum might have some of the answers solved by the time we needed it so we could carry on from there. As you know, the ramifications of that over-all study is a tremendous job in itself.

DR. CROSS: I was looking at it from a practical standpoint. Maybe this is out of order, but if gas comes in at 12 cents a thousand cubic feet in Eastern Kansas or Western, Missouri, what is the coal man going to do with ordinary bitimuncus coal unless he puts out a very superior product for domestic heating?

DR. CONDRA: It would be a great help to us if, in your research, you would take these coal beds through Missouri, Kansas, Oklahoma, and insofar as they can be correlated with ours, work them out because there certainly are a lot of chemical differences.

MR. NICHOLS: I saw a most illuminating moving picture recently, "Plastics from Coal" and as an ignorant layman, I was thrilled with it. Here past ages can be put to work for the middle west. Let's keep our minds open for things even undreamed of today.

If there is no further discussion we will have my good friend, Mr. L. C. Heckert, formerly with Pittsburg Teachers College on "Post War Use of Ammonia."

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DR. HECKERT: You have been discussing things that occur in the ground, but this is a secondary resource. The production of ammonia of course has been increased tremendously in the United States because of the necessity of it for the war. It happens to be the basic material for all of your explosives. Ammonia production in the United States previous to the war was almost entirely along the Atlantic Seaboard except what little was recovered from some of the coking plants, which is a very small amount, but synthetic ammonia was made along the Atlantic Seaboard. With the possibility of possible bombings and submarine attacks the War Department, at Mr. Nichols' suggestion, decided to put a few of the plants in the in the interior of the country; they also changed the process a little bit in that the hydrogen for the ammonia, instead of being obtained from coke is obtained from gas. The large production of ammonia, with a good deal

of it centered in the Midwest here, is going to be some little problem on how to use it. There are lots of uses for basic chemicals and we have very few basic chemical plants out in this region and we won't get a proper development of a good many of these resources we have here until we do get some basic chemical plants because the utilization of these resources, as such, generally involvessome kind of processing before they reach the final stage in which you and I use them.

We find very little chlorine, as such, reaching the ultimate consumer. It is used as processing and we cry a little bit because we do not use our Kansas salt to produce chlorine. We won't find a use for that chlorine until we get some industry that needs chlorine; maybe it will be paper and pulp, or something else, but until we establish some basic chemical industries in this part of the country, we probably won't find ourselves using many of the many resources that we do have. We want to get some basic chemical industries here to see if we can't start a little widening cycle of industry growing. If we have cheap ammonia, there may be something that can be done with it. This section of the country is an agricultural center; we call it the bread basket of America. We are taking out of the soil every day, every year, a very considerable amount of nitrogen, phosphorus, potassium and other things.

I think if you will examine the records of the past few generations, you will find that the crops taken off of the soil per acre has changed quite a little bit. When I was a boy in Iowa a farmer who got 30 or 35 bushels of corn to the acre was doing pretty well; a blue ribbon winner would be a fellow who got 70 or 75 bushels per acre. I think last year the top production was 138 bushels per acre. Now, you can't take that much out of the soil without putting something back. I am not going to tall

about fertilizers because Dean Curtis has that subject, but nitrogen is one of the things required in fertilizer. Fertilizer consumption in this part of the country is extremely small compared to what it should be if we are going to continue to feed not only this country but the occupied countries and our Allies.

A farmer can grow part of his nitrogen; I don't know whether it is economical or not; it may be we can make it easier than he can grow it. There is just this much to be said, that whenever any synthetic process has had to compete with a natural process in the past the synthetic process has always won out. I don't think that is always going to be true because some synthetic processes are too involved but, generally speaking, it at least has a chance. I think possibly it would be cheaper for a farmer to buy his synthetic nitrogen or nitrogen fertilizer and put it on the soil instead of depending on the crop rotation or some other natural phenomena to put it into the soil.

There should be a tremendous demand for fertilizer after the war. We all foresee in the present year a food shortage, and a lot more after the war; there has been too much about it in the papers already so we ought to realize perhaps that we are going to have to do something about it.

Somebody has said that if we were to use a small amount of nitrogen on the wheat farms in western Kansas we could increase the yield there some 20 bushels to the acre. I don't know whether that is true or not, I doubt it very much, but at any rate it would help somewhat, so fertilizer is one possibility in the post-war use of nitrogen.

Ammonia has a lot of other uses besides as fertilizer. It is a basic alkali. It does not compete, as such, with lime, particularly, but it does have a lot of uses. Probably a lot of things could be done with ammonia

or will be done with ammonia in this section of the country and other places after the war because of the availability.

I don't know whether the price will change materially; it can be made cheaper. I think you can look forward to ammonia at around $30.00 to $35.00 a ton after the war, and compare that with your $90.00 before the war and it does offer a little incentive for further development. I think there is a very distinct possibility of ammonia utilization. Reforming gases or oils with ammonia leaves the cyanides and nitrates, and out of that comes a whole series of rather useful substances in the utilization of ammonia for urea formaldehyde resins and other substances. There is a tremendous outlet for ammonia; it can be made reasonably cheaply and in quantity.

There are several ammonia plants in this area; we hope to keep ours going; I suppose the others hope to do the same thing, and I do not believe even this section of the country will be over-produced.

Of course, an ammonia plant can also be utilized for the production of other things besides ammonia and a good many of those things that are utilized in the making of ammonia can fortunately be used in other ways. It is not very much of a change in an ammonia plant to convert it to a plant manufacturing methyl wood alcohol and that can be oxidized quite reasonably to formaldehyde, and in formaldehyde you have one of your basic ingredients of the plastic industry so the ammonia plant could provide the basic material for the plastic industry.

The word "plastic" is a very magic word. We have been calling most any kind of a gummy mass that a chemist gets that he cannot crystallize, a plastic, but when you talk about plastic, you are talking about something that is quite large in scope and does not mean very much, but nevertheless

chemists do have very distinct ideas as to how these things we do call plastics are made and why they are made and what they will do.

They are going to play an exceedingly important part in our future lives. It is quite likely that most of our wood construction, certainly most of our gadgets and furniture and things like that will be made from plastics, or at least a plasticized wood after the war is over and these compounds become more available and cheaper.

It probably won't take very much of a drop in price of formaldehyde to extend its uses considerably. With the number of ammonia plants we have, the cost of production of formaldehyde will go down quite appreciably and it should extend the uses of these plastics for articles that we cannot afford to use them for now. Of course, ammonia can go into any number of ammonia salts. We have been able to make a pretty good grade of ammonia sulphate from gypsum. It is a rather simple process. I don't know whether it is economical yet or not but it can be made.

Tying up your ammonia with the other resources in this whole general area, the major outlet, it does seem to be in the field of fertilizer or in the field of plastics and we are in the hope that those markets can and will be extended.

MR. NICHOLS. Mr. Spencer, have you anything you want to add? When you talk of plastics you are talking right down a Middle West alley.

MR. SPENCER: First, let me say I know no one who has worked more diligently for the Middle West than J. C. Nichols. Our plant is today producing in excess of its designed capacity and of course, even though they are not using ammonia nitrate, there is still a strong military demand for hydrous-ammonia and there has been no disposition to curtail on ammonia production, as such, although in view of our excess capacity or producing

in excess of our rated capacity, I think there is some ammonia immediately available for the use of these things Dr. Heckert is talking about, and I do not think it will be long until some small portion of what is going into military use will be diverted. There is ammonia down there, lots of it, and it is cheap and we can start pretty fast on it and we need it now.

DR. MILITZER: For a permanent industry, would a small fellow have a chance, if he coordinated with other producers?

DR. HECKERT: If you want to start small and coordinate your work with other groups, that is one way of attacking the problem; the other is to start with a large production and hope to attract other industries to that which can utilize a portion of your products. Usually the first way is the way it is done. In this particular case we did not have any choice in the matter.

DR. THROCKMORTON: We are very much interested in this from an agricultural standpoint. The possibilities of using much greater quantities in eastern Kansas and Missouri, and Oklahoma are enormous. Let us not go out to western Kansas on the wheat fields; we have tried that and we cannot get an increased yield out there; old man moisture tells us what we are going to get and not nitrates.

MR. NICHOLS: Talking of wheat - some day we may grow perennial wheats. W. L. Nelson of Tulsa University is here; Professor of Refining for Tulsa University.

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DR. NELSON: I am glad to be here and I was absolutely stupefied at the magnitude of the subject that I was to talk on "The by-products of the petroleum industry". There are a number of reasons why the subject of the by-products of the petroleum industry might be a complicated one.

First of all we start out on one tack; we take one hydrocarbon and start out to make another more useful one and immediately we find ourselves in many instances making six products instead of one, and in transposing each of the six we run into six more from each of them and we get by-products from by-products and it grows into such a maze of possibilities, literally hundreds of different organic hydrocarbon products that I simply refuse to be pinned down to try and discuss that whole field.

What I had in mind today was to try to put my finger, if that be possible, on some economic features of the development of petroleum chemicals or the petrochemical industry, as some have been calling it of late, I would not want to be quoted on the statement I am about to make, but if we wish to emphasize the possibilities that are ready for exploitation with regard to petroleum I might say this, that if we are prepared to spend some three billion dollars or more in an attempt to manufacture all of the organic chemical products normally used in peace times in the United States that we might do that and probably in so doing not be using more than 10 percent of all our normal production. I do not wish to leave any misapprehension there about whether I believe or not that we should do any such program as that or whether such a program might be possible.

One other point is that whereas we put a large amount of petroleum into the manufacture of a single material, the amount of material that finally gets over into the product we desire made may be very small but the rest of the material is not lost and that is the basis I use in making

such a statement as that. I imagine that if we were to start out to produce all of the organic chemicals manufactured in the United States from petroleum that we might have a business whose products would be available to the extent of over three million dollars a day.

We are gaining experience during the war in the manufacture of chemical materials. We have not been doing that in the past to any large extent in the petroleum industry; we have talked a lot as though it were a chemical industry but we have not changed materials. In fact at the present time the contemplated program for so-called alkylate for one hundred octane gasoline is some four million four hundred thousand gallons per day.

Isopentane, another hydrocarbon that is present in natural gas and petroleum we are contemplating the manufacture of some 1,890,000 gallons per day and I mention those figures first to emphasize that we are gaining experience in a rapid and fast way in the manufacture of chemical products, and to indicate that those quantities that I just mentioned are extremely large as compared with organic chemical manufacture in the so-called chemical industry.

For instance, the material acetone that even the layman sees frequently, was manufactured in the last years of peace at the rate of thirty-eight thousand gallons per day rather than the four million that I just mentioned of alkylate and ether to the extent of only six thousand gallons a day rather than 1,890,000 gallons of isopentane. Even the rubber industry which we like to think of as a tremendous venture, and it certainly is that in many ways, when you put it on a pound or gallon basis it does not seem to be so large. Butadiene for rubber, if it were all made from petroleum, according to the last statement by the Baruch Committee will be required only to the extent of four hundred thirty-three thousand gallons per day.

I mention those several figures to indicate and substantiate the statement that I made earlier that a rather small amount of our petroleum resources would go a long, long way in manufacturing chemicals.

I listed ten common organic chemicals, acetone, ethyl, acetate, butyl alcohol, methyl alcohol, ethyl alcohol, ethyl ether, benzene, toluene, xylene and napthalene. I listed those ten and converted the quantities of those marketed during peace time to a gallonage basis in order to compare them with our petroleum production and find that the total of all those only amount to .7368 of 1 percent of our production of four million four hundred thousand barrels a day. That leaves us with one fact for sure, and that is that regardless of how elaborately we may go into a petrochemical industry in the future or utilize petroleum for by-products that there will still be a lot of petroleum left for using petroleum products as we have been using them in the past. I do not wish to infer, however, that such a venture into the petrochemical industry would not be a tremendous thing. We might not use a great amount of oil but the cost of building plants for such a purpose would be extremely large.

I might quote some plant costs and I am more of a construction engineer than a chemist - I feelmore at home in that line. Ordinary topping plants have been built as low as $25.00 per daily barrel capacity and complete refineries have been built as cheaply as $250.00 per daily barrel capacity. As against that, 100 octane plants have cost thus far $900.00 per daily barrel and up to $1400.00 and one I know of even higher than that. Butadiene plants are a little difficult to define because there are many ways of making it but based on a per barrel basis of butadiene which is to be dehydrogenated by the butane dehydrogenation process.

Those figures, as you will note, are tremendously large, the highest figure 100 times and even the lowest figure several times as expensive as

as petroleum refineries as we know them. That means that although we do not use much oil in manufacturing chemicals that we might have to put up some mighty fancy and intricate and complicated processes that lead from one to another far more complicated than we ordinarily consider as a refinery. Just estimating it, you might expect that manufacture of chemical products from petroleum might be ten to thirty times as complicated as ordinary petroleum refining.

Why haven't we made these developments in the past? I think the reason is obvious to those who are familiar with the chemistry of those hydrocarbons that compose petroleum. They are stable unreactive types of material which have largely defied any attempts to cause them to react in a vigorous way. We tried for several years to identify some of them and had great difficulty and are still laboring with the problem.

What is required is high temperature equipment in which the time can be controlled to fractions of a second and in which the flow of the reacting materials can be confined or directed. In the past, such process requirements have been met by the development of metal equipment and the same may be necessary for high-temperature processes. There is the undoubtedly formidable difficulty of finding fairly cheap alloys that can withstand a temperature of 1200° or 1600° Fahrenheit, a difficulty so formidable that possibly we must resort to vessels or reactors whose walls are hollow so that they can be colled, -- or perhaps we must resort to the use of ceramics ware.

An alloy or metallic material having the properties ascribed to iron-columbium would revolutionize the field of organic chemical manufacture. The same would be true of any mechanical equipment, metal or ceramics ware, which would permit the controlled operation of pyrolytic

processes at temperatures of 1200° to 1600° Fahrenheit. Such materials or processes would permit the manufacture of vital organic base materials, namely acetylene, olefin, diolefin and aromatic hydrocarbons, at a low cost and in an abundance heretofore undreamed of. Such hydrocarbons in abundance and at a low cost would open a veritable fairyland to the exploring talents of organic chemists. Needless to say, before a technical group, numerous chemical processes which require the above-named hydrocarbons, are already well known, but commercial development of these processes has had to stand idly by, until cheap organic-chemical base stocks were available. In fact, these hydrocarbons constitute the base materials for most of the organic chemistry known to us today.

An almost numberless array of organic chemical products can be manufactured from petroleum oils. A Southwestern States Petrochemical Industry could supply to the nation a quantity of organic chemicals equal to all of the peacetime organic chemicals heretofore manufactured, and in so doing, become the center of organic chemical manufacture for the entire United States. The amount of oil required would be very small, perhaps not more than 15 per cent of the normal oil production of this area. It must be mentioned, however, that most geographical areas in the United States have the same opportunity because the small amount of oil required for the purpose would constitute only a minor part of the operating expense.

To develop such an industry to the full degree would require the investment of several billion dollars but would produce products whose worth might exceed three million dollars per day. It is probably too much to expect such quantities of organic materials to be made from petroleum or that all of such a development can be brought to the Southwest area, but even a modest share of such an industry would be a vital stimulus to the now lagging Southwestern States.

I wish I were able to take a series of organic chemicals and trace through the dozens, going into literally hundreds of organic products and their commercial derivatives. I hesitate to even start on that because it would certainly be boresome and would go on so indefinitely that I think I will leave that to Dr. Oberfell this evening and others who may speak on by-products of petroleum.

MR. NICHOLS: I am going to ask Dr. Brewster of Kansas University to go on with the subject.

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DR. BREWSTER: The subject which Mr. Nichols gave me was the one of producing gasoline from natural gas, and I am in full accord with him in calling us together. It has to do with the relative abundance of petroleum reserves and of natural gas and the figures on that matter are not known to me at all. There are men here who doubtless know about that but the point of making natural gas into gasoline would be connected with the supposition that our petroleum reserves may play out before the natural gas resources and therefore it might behoove us to have some method in mind whereby natural gas could be converted into motor fuel.

The chemistry of it is a little involved because although methane is our most abundant hydrocarbon, it is the most unreactive of all and is the least convenient to work with.

Decomposition of methane by heat in the presence of catalysts gives carbon black, hydrogen, unsaturated gases and liquid hydrocarbons of both the aliphatic and aromatic series which may be used as motor fuel.

I cannot take time to review all of the patent literature on this subject but I can sum it up in short order. The processes which have been

tried are of two general types, the direct process and an indirect process. The direct process is one of pyrolosis of the gas to methyl, methylene radicals and polymerization to hydrocarbon. That process is in reality a part of the process of making carbon black from natural gas by the thermal decomposition process.

Two carbohydrate radicals may unite to give acetylene or six of them may combine to give benzene.

Much patent literature exists on this project. Temperatures used range from 500° to 1200° Centigrade; pressures form 1 to 400 atmospheres. Many kinds of catalysts, mostly metals or their oxides, have been tested. Yields on experimental batches have been as high as 2.6 gallons of liquid hydrocarbons from 1000 cubic feet of gas, about 50 percent of the theoretical quantity. The volume of exit gas, mostly hydrogen, is about 1.5 times that of the inlet natural gas. No process based on this method has reached commercial production. More investigation is needed. In France and Germany coal and steam furnish the carbon monoxide and hydrogen which are then converted into liquid motor fuels. Axis nations obtain their gasoline by this means. The cost of gasoline made from natural gas by this method will depend primarily upon the yield which can be obtained.

The production of benezene from natural gas would be very beneficial because it is a relatively high priced material. We can make hydrocarbon simply the same way and then the monoxide and hydrogen can be formed to form carbon, so it is a roundabout method but is easier of accomplishment than either the pyrolysis or the polymerization method. The Bureau of Mines is interested in the study of this process and have carried on considerable experiments with it and I have seen reports of the cost of producing a motor fuel by that method of about 8 cents a gallon which is more than we have

been in the habit of having gasoline cost but in the future we may not obtain gasoline as economically as we have in the past. Whether our natural gas should be used or could be used most advantageously by converting it into gasoline or using it as a fuel as it is, is a subject on which I am not prepared to give the answer.

I am told by the geologists and oil men that when our petroleum reserves diminish by the present method of producing them, we will have to merely change our method of producing, send down some hot water and bring up some oil again so we can extract the oil from those shale and oil sands better than is now done by drilling into the well, but the problem of converting natural gas into gasoline is one that may be considerably important in the future, however, not just at the present time, but it is a problem which of course must be studied in the present in order to be ready for operation in the future, so I would be glad to have some discussion as to the advisability of the proposition, anyway should we use our natural gas as it is or make it into gasoline? In closing, let me say again we are indebted to Mr. Nichols in his well known leadership in calling this conference.

MR. NICHOLS: Mr. Wagner, Consultant for the Petroleum Industry.

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MR. WAGNER: I doubt if there is very much I can add to what has been said, but I would like to bring out one thing which Professor Nelson and Dr. Brewster mentioned, and that is the question of economics in the manufacture of by-products from petroleum. I am sure you have all heard some very glowing descriptions of the money that can be made by taking a barrel of petroleum and converting it into chemicals and many people have spent a lot of their money in such promotion schemes and have usually wound up with nothing

but a piece of paper that they could paste on the wall. Ninety nine times out of a hundred that has been because of the failure on the part of the company that started out to study the economics of it; they tried to make the tail wag the dog. If you want to make ethylene, for example, from petroleum you can convert a sizeable proportion of the crude oil into ethylene, but you probably could not make more than around 30 to 35 weight percent from that crude oil or any other fraction of crude oil you started out with. The other 60 or 70 percent would have to go into something else, fuel or some other product that you could not utilize in the particular scheme that you were working on. That means if you want to make by-products and chemicals from petroleum they must be truly by-products.

You must take the by-products from the refining of petroleum and convert them into the business of making chemicals from petroleum as a raw material because then immediately the chemical manufacturer has to go into the business of refining crude petroleum and he finds himself in a field he doesn't know anything about.

Unfortunately a lot of oil companies have done work in the manufacture of chemicals from petroleum and they have gone into a field they didn't know too much about and it has not ended too happily but some sort of cooperative venture between chemical companies and oil companies or the building up by the oil companies themselves of a branch of their company along the lines of a chemical manufacturing company is going to be the ultimate answer to the manufacture of by-products from petroleum. I think a lot of people ought to think of those things when they start to figure on making by-products from petroleum.

MR. NICHOLS: We will have Dr. Huntington, Director of the School of Chemical Engineering of the University of Oklahoma talk to us about chem-

ical industries from petroleum and natural gas.

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DR. HUNTINGTON: Thanks, Mr. Nichols, you are a great leader for our area. The subject of by-products has been covered so well that I will touch on another topic that will be appropriate for the occasion, that is, to consider some of the fundamental factors governing the location of any chemical plant and the reason I put this map up here is to show some of the factors that govern the location of refineries in the United States. Although crude oil is produced in this area to a large extent, Texas, Kansas and Oklahoma, you will find that the large refining centers are located around Chicago and some around Philadelphia. The reason for that is that the population center of the United States is, of course, in Indiana or Ohio. If you would take a triangle and draw it from Boston to Milwaukee, down to Birmingham and back to Boston, you take in 9 percent of the area of the country, but in that triangle there are 50 percent of the people and 60 percent of all the fuel is used in that triangle, so it is natural that you should move your crude oil into the area where the material is being consumed.

Then you take sulphur. It is natural for sulphur to move from the Eastern Seaboard because out of 32 pounds of sulphur you produce 92 pounds of sulphuric acid. Where you have gold and silver and copper there you have such a large tonnage compared to your finished product that you need to concentrate your material at the mine; for that reason the concentration plants are located around the mines.

One thing that has improved the refining situation in the southwest is the fact that they found they could move finished products through a

pipe line, as many as several different products without mixing them appreciably; that has helped the southwest very much. For that reason it is well to refine the material in the southwest and pump the finished products through the line. You can pump more gasoline through the line than you can crude oil because it is less viscous. Things of that kind are bound to help the southwest.

It is interesting to notice, when you look at the world as a whole, that most of the large cities are at fairly low elevations. I think that is because water transportation has been so much more favorable than transportation by rail. Of course, the war has upset that because you cannot move oil by tankers now with all the tankers sunk, and it was for that reason they have put in that 24 inch pipe line across the states. Of course, after the war that 24 inch line may be a gas line. Coming back to these larger cities at low elevations, there may be an advantage there some day because if we are coming into an era of aviation the cities of higher altitudes may not be at a disadvantage. People are going to fly from ocean to ocean and a city with a high altitude will thrive just as well as the city on water level. That is something to think about.

There is quite a bit of talk about the oil industry playing out in another 14 years, that our reserves haven't been showing up as fast as our consumption. Of course, the oil industry has gone through scares like that before and has come out ahead and we have had headaches because we had too much crude. I don't think anybody believes that the oil industry will play out that soon, neither will the gas industry play out in 30 years, but I think we will have to go in more for secondary recovery as time goes on and there is a big field for that kind of production throughout the southwest.

These fields have 25 to 50 percent of the oil left in the reservoirs

and in some fields as much as 75 percent. They are proving we can get out a good percentage of that by water flooding; no doubt there will be other methods developed as time goes on for getting out even higher recoveries.

The University of Oklahoma, at least speaking for the School of Chemical Engineering is ready to undertake any problems that you may want to suggest to us providing we feel we are qualified to tackle it. I am glad to have had this opportunity of being with you here today. Thank you.

MR. NICHOLS: I ask Dr. Militzer of the Department of Chemistry in Nebraska to say a few words.

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DR. MILITZER: Mr. Nichols, I will confer upon you the title of Honorable Dean of the Great Plains and a natural born leader for all of us. I told you in my letter I did not think I had anything much to say, but if you want me to deposit a little seed of thought, I might do so and if it is worth anything it might sprout and if it doesn't it will just dry up and blow away.

I have been concerned, perhaps our committee was concerned a little bit about the licking that the small business man has been taking, and when he has been getting up he has been getting kicked where it didn't do so much physical damage as hurt his mortal pride.

Take the case of Homer Hope up in Lincoln, Nebraska making milk cans. Homer Hope doesn't have enough money to do any research. We went into see Homer Hope and said "Well, Homer, you are making milk cans here, you have been making them for 25 years, you stand a good chance of losing your business over night unless you do some research." Then he comes back and says "I can't afford it". What are you going to do? Our committee

was trying to evolve something in the way of an effort that could be made for the small business mon in the way of a research organization that might be set up to help him. He can't employ a chemist, even at $2400.00 a year and expect to reap any reward. You might, in the City of Lincoln, for instance, get together a bunch of merchants and they might put in $500.00 or $1,000 for a research organization and say "now boys, go to work, turn out something so we can protect our future against changes in manufacturing processes".

That is all very well, they are willing to put in money but what kind of a research organization are you going to set up for them? It is a very difficult thing for this reason. You have got to decide upon what kind of problem to attack and suppose you get an answer, how are you going to distribute the profits to a hetrogenous group of men? It is very nearly impossible, so, what kind of research can you give a small little fellow so he can insure his future. Cooperative research with the industries is not a new idea, it is an old idea.

Take for instance the insurance companies. They have cooperative research departments into which they all pool money and they all draw out the benefits and if we are going to get any benefit it seems we have got to have cooperative research that extends from North Dakota clear down to Oklahoma and doesn't confine itself to any one particular city. Perhaps we can take all the milk can manufacturers like Homer Hope, - I don't suppose there would be over a dozen or fifteen in this area and have them put together some money in research and get some developments in which the benefits can be spread out through all these manufacturers.

Of course, the object of this Council, as I see it, is to try to coordinate research in this area and also to exchange ideas. If we want

to do anything in a tangible way, so far as the small business man is concerned, I merely suggest this idea of cooperative research between individuals and manufacturers of a single product, and let it cover an entire area rather than starting from just a little isolated section like Lincoln, Nebraska, because I don't think anyone alone can do very much. This of course is entirely off the subject but it is just a thought. Nebraska is ready Mr. Nichols to follow your well known leadership.

MR. NICHOLS: I do not think it is off the subject, I think it is very fine - it is one of the things to which I hope we can work. We have Dr. G. L. Cross, Acting Director of the Research Institute of Oklahoma Institute who will talk to us on "Research Organizations as an Aid to Industry".

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DR. CROSS: The general topic under discussion here is one in which I have been interested for sometime and I want to express my appreciation to Mr. Nichols for making this conference possible. It seems especially promising that the stimulus for the meeting should have come from one engaged in a private enterprise rather than from some public institution. I have just a few comments that I should like to make concerning the problem of utilizing the research facilities and personnel of the Mid-West in the industrial development of the area.

A problem in any area, particularly in a partially developed one such as our own, is that of bringing the research man and the industrialist together so that the efforts of one may supplement those of the other. The need for research in industry is now widely recognized, and many industrial organizations have developed elaborate research departments of their own

tc satisfy their needs. However, the majority of the smaller corporations, especially those in the Mid-West, do not have research facilities, and even the major companies, with large research budgets, frequently experience a need for specialized research which is not available within their organization. In the East, industrial corporations may obtain the services of private research organizations or of research institutes connected with colleges and universities. In the Mid-West, development along this line has been rather slow. With the exception of a few private laboratories, research equipment and personnel in the Mid-West is likely to be found only in the colleges and universities. Because the state colleges and universities cannot usually enter into contracts with commercial organizations, their research facilities are often practically unavailable to industry for the solution of specialized problems. We certainly need a complete research library in our area.

Commercial organizations have frequently gotten around this situation by financing research fellowships in various institutions so that research projects of interest to them could be worked out as a part of a master's or doctoral program. However, under the best conditions, this is a make-shift arrangement and it is desirable to have a plan whereby the research facilities of an institution can be utilized to the fullest extent by the various corporations and business organizations. I think that this will be especially true during the period of reorganization following the war. To meet this need in Oklahoma, the University of Oklahoma Research Institute was organized and incorporated under the laws of the State in 1941.

I will not bore you with details concerning our organization, but it occurred to me that a brief report of its activities during the past two

years might be of interest to individuals who are working toward industrial development in the region. The Research Institute exists as a corporation, in a sense separate from the University and therefore empowered to enter into contract with any bona fide agency desiring its services. Its articles of incorporation make provision for patent rights and royalties coming into existence as a result of the activities of its research personnel. There are one-hundred or more members of the institute scattered throughout the nation. Naturally, a number of them reside in Oklahoma and several members of the faculty of the University are included. The business affairs of the Institute are managed by the Director who is responsible to an Advisory Committee which in turn is responsible to a Board of Directors. The research is done under the direction of scientists who are members of the faculty at the University of Oklahoma.

A commercial organization desiring research services visits or corresponds with the Director. The Director, after consultation with the appropriate member of the research staff, submits an estimate of the cost of the research. If the estimate is satisfactory to the company, a contract is drawn up and signed by both parties.

In most contracts there is a provision for a stipend for a graduate fellow who will do most of the research, under the direction of a faculty supervisor. There is also a small honorarium for the supervisor and a provision for the purchase of equipment and supplies which may not be available in the department in which the research is done.

The Research Institute collects a fee of 20% of the total cost of the project and this money is used for administrative purposes and for the development of a fund to finance independent research on the campus.

The results during the first two years of the existence of the Institute have been so promising that it can now be stated with confidence

that the plan was a good one. During the first two years the Institute, despite the retarding effect of the war, has accepted 23 contracts for research and the gross income for these projects has been in excess of $36,000. Twelve projects have been completed and renewals for several of them have been received and approved. The projects are distributed in the fields of physics, chemistry, plant sciences and engineering. A relatively large number have been submitted which we could not accept because of the lack of space and facilities for expansion.

When the Institute was organized it was thought that our greatest contribution would be to smaller companies which had not been able or had thought it inadvisable to develop research departments of their own. While we have had contracts from many such companies, perhaps the greatest use of our facilities has been by companies with large and well staffed research organizations but which needed certain highly specialized information which could better be supplied by a scientist working in the University. Similarly we had anticipated that our clients would be secured mainly from Oklahoma industry, and it is true that the bulk of our business comes at least from the vicinity of Oklahoma, but we have written contracts with organizations as distantly removed as Birmingham, Alabama, and Washington, D. C. The greatest demand has been for research concerning the development of spectroscopic and polarographic methods of analyzing materials which are used in various phases of the petroleum and chemical industries. One of our most important projects, financed by a large petroleum company, involves the use of spectroscopic methods for controlling certain phases of the manufacture of synthetic rubber. The usefulness of infrared spectroscopy in solving industrial and war research problems is becoming widely appreciated and the Institute has recently accepted contracts to manufacture infrared

spectrographs of a special type for a large petroleum company and for the Naval Research Laboratory at Washington, D. C. Methods of using the instrument (developed by Professor J. Rud Nielsen) for making quantitative determinations of short-chain hydrocarbons, have proven so successful that the technique is being adapted for the quantitative analysis of blood, urine, and many other substances. Thus, the infrared spectograph is becoming a most important instrument in the development of industry in the Southwest.

In like manner, the polarograph is receiving considerable attention in our laboratories. Recently, we accepted a contract to develop a technique for making quantitative analyses of aluminum compounds in a vapor stream in the plant of a petroleum company in Oklahoma. A technique was devised by which such quantitative analyses could be made in less than ten minutes time.

There has been a considerable demand also for research dealing with the dehydration of natural gases. One company has spent $9,000 on this research in the last eighteen months and would like to spend more if research talent were available to handle the various projects. Research on iron and lead corrosion is also receiving attention and the data obtained last year are already being put into practical use in the oil and gas fields of the Southwest.

It is logical that many of the projects submitted should come from the petroleum industry, but the use of the facilities of the Institute by other branches of industry and by agriculture is increasing. Recently we accepted a contract to develop and study several strains of hybrid corn, and a breeding nursery was established last spring at Norman. The new strains of corn produced there will be planted experimentally and

studied in various parts of the Southwest ranging from Kansas to Texas and Louisiana.

It is hoped that in the future the Institute may make three rather distinctive contributions to the development of industry in the Mid-West and Southwest: Viz; (1) Increase its research service to the small companies which lack facilities of their own; (2) continue to provide highly specialized research for the larger companies which have research organizations of their own; and (3) take increased initiative, by using cooperatively the facilities of several departments, in the development of independent research programs designed to utilize the natural, industrial and agricultural resources of Oklahoma and the adjacent areas.

I have presented this material concerning the University of Oklahoma Research Institute to this group because I regard the Institute as a resource which I hope will be utilized to the fullest possible extent in developing the potential industries of this area. It seems clear that there is, and will continue to be, a heavy demand for research of the type that the Institute is able to provide. We estimate that our program could have been trebled during the past year had we been able to procure additional research facilities and personnel. Under these circumstances, and at the risk of developing possible competitors in the future, I should like to suggest that it might be well to consider the possibility of developing similar agencies for research in other institutions in the area. If we experience an increased industrial development as we all hope may be the case, all available research facilities will be needed, and provision should be made for College faculties to work in the closest cooperation with industry.

MR. NICHOLS: Dr. Cross, you are certainly on the right track and all of our states should set up such an organization. We all know how well Wisconsin has done. I call on Dr. Condra of Nebraska to talk about the water resources of the Middle West.

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DR. CONDRA: Mr. Chairman, on the subject of water resources in the Middle. West, I am not quite equal to all that subject.

I will go over some things today, discussing this question of the relation of the water supply to this plan and to its development, and make some references to my own state, but I will be discussing a thing that either one of these other state geologists could handle.

We have just gone through the matter back home of making reports on water possibilities for defense plants and in our state 200 million dollars more of such plants have been established primarily because we had information. This morning the state geologist of Missouri told you how it was that a training camp was moved from Iowa over to Missouri because they did not have water at the first place.

I am not going to go into all this question of what water is. We know what it is, snow is water, rain is water and clouds or vapor is water; water in the ocean is water, water in the ground is water, water on the ground is water, and it is about time we began to think about the story of water in relation to our various areas and sometimes about the concentration or storage of water at those places.

In our own state we have nearly 16 million acres of land in soil conservation districts and one of the big purposes in all of the activities in planning every farm is to devise a plan whereby you will get more water

into the soil, thereby growing better crops. Too generally in the Middle West the waters run away to destruction and it has been bad destruction, taking away the top soil by floods.

The engineers of the War Department and those who have been doing cooperative work in water research know we can't check that thing, that we can control the movement of water off the farms down to the streams and we can run the water in the ground that will rebuild up the ground water and by a survey we can find the quantity of ground water available for use. We have put a lot of money in our state, in cooperation with the Federal Government, into ground water surveys. We have surveyed places where we can store the flood waters, with splendid results.

We have in Nebraska a thousand times as much water in the ground as you will find in the surface at one time, and for many years we have been neglecting that big storage of the water in the sands beneath the soil and now we are bringing that water up to the surface at places where it is economically feasible and we are able to say as a result of those surveys whether you can or cannot irrigate. In our own state, we have found many new water supplies and the result of these researches costing thousands and thousands of dollars, have enabled us to tell any farmer whether or not he has water for irrigation and whether or not his soil is soil that will irrigate and I want to leave that thought with you, that it is important in Kansas, it is important in Oklahoma, it is important in Missouri that we make good surveys down to the end point.

It is important that we make the most and greatest use of our water. We are using water now in our state that was snow fall; formerly it ran out at the so-called flood area, non-irrigation areas and away to floods. Now we are putting that in reservoirs. Take the Kingsley Dam. When I think of

that Kingsley Dam I am thinking of water that ran out to very little use in an area where, a few years ago, to irrigate we would tie into a stream and the stream would be dry, the water having gone back and not being there when we wanted it. Today we are stabilizing those projects.

We have to give people not only the water but we must know about the chemical quality of the water, the suitability of the water for human consumption, the potability of water, and you men, I am sure, know that this question of water pollution is a very important and critical one. The freedom from pollution of the water used by our cities is one of the biggest subjects today in our country and I hope you are in sympathy with Washington and all these states that are trying to guard water against pollution.

I am asking you men if you will, and I know you will, to have a friendly relation with the War Department when it is studying water for use, have a friendly relation and a friendly spirit with the farmers when they undertake to use water and not let it go to waste and not let it run away and carry away your top soil, and I hope you will be in sympathy to help in every state and every industry and give them any service you can.

In our soil conservation service we have technical men who go down with the farmer, not to regiment him, but to give him information so far as he can in regard to the soil and the crop, and I know of farmers where we have ponds now by the hundreds and thousands, where they now have water for stock and a little irrigation for gardens and a pond for fish. So, in the case of the use of water in the Middle West you have a logical answer to your water service problem, and if we tackle that job in the cities and with the farmers and everybody, we are going to increase the growing capacity of a lot of these lands double and treble, and we will not make a lot of mistakes by trying to do the impossible things at certain places.

This has been the hobby of my life, although I am a geologist and all that and work in these other activities, I am telling you we have got a big field ahead. I hope you won't think I have been too earnest about it. I have tried to tell you part of it by motions and rapid talking.

MR. NICHOLS: I know all the time I was in Washington when we were talking about any defense plant or any industry, one of the first questions was the quantity and quality of water available, and if anything, I think Dr. Condra has not laid quite as much stress as he really intended to on the importance of water to industry. Certainly our water supply is important to new industry and greater agricultural growth.

(At this point an adjournment was taken until the dinner at 7 o'clock.)

JUNE 7, 1943, 7 o'clock P.M. Windsor Room, Hotel Phillips

(Mr. Nichols introduced to the audience the head table guests: Deane Malott, Chancellor of the University of Kansas, R. A. Seaton, Director of Engineering, Kansas State College, O. J. Ferguson, Dean of the College of Engineering of the University of Nebraska, W.L. Nelson, Professor of Refining of the Tulsa University, L. C. Heckert, Chemical Engineer of the Pittsburg State Teacher's College, Leonard Sorg, Chairman of the Kansas City Division of the American Society of Chemical Engineers, Mr. Ward Gifford, President of the Chamber of Commerce, H. A. Curtis, Dean of Engineering of the University of Missouri, W. H. Carson, Dean of College of Engineering, Oklahoma University, Dr. Harrison Hale, Head of the Department of Chemistry of the University of Arkansas, L. E. Hawkins of the Oklahoma Agriculture Experimental Station, Dr. Lloyd McKinley, Department of Chemistry of the Wichita University and Richard Robbins, Chairman of the Kansas Industrial Development Commission, and expressed

regret time did not permit the introduction of the other schoolmen present).

(After the introductions Captain H. W. Decker, Chief of Ordnance of the United States Army presented a citation for research in the saving of steel in manufacture of shells to Bert Heinrich, Engineering Superintendent of General Motors at Kansas City, Missouri. Mr. Maynard Murray, Local Manager of General Motors joined in the citation.)

MR. NICHOLS: Gentlemen, I don't know where we could go to find a more practical example of real research and real results than in Mr. Heinrich's achievements. If we can just apply that same skill and ingenuity to industry and agriculture, we will make industry balance agriculture some day in this part of the country that has been declining so rapidly in population for the last 20 years.

I don't know whether you all saw the map on the wall in the conference room that tells the sad story of the declining population of the Middle West, but I take it as a challenge to that decline of population when we can get some forty educational men to come in and meet with private research men in this city, and I hope they will extend such meetings to other private research men in our area to bring into use our great resources. One of the things we are trying to do is to first get a survey of just what the raw material resources of these six middle western states may be.

Then we want to make a composite map showing all our raw products and then get out an honest-to-God sales map on this area.

Then we want to get our educational and research men in our schools, and our private industrial research men working together shoulder to shoulder, on both the theoretical and the practical approach to get results. We want to encourage the establishment of fellowships by private

industry in the colleges and universities of this part of the country. Too many of our industries are today going to Ohio, Wisconsin, Michigan, Pennsylvania and other eastern schools to establish scholarships in research departments and carry on the work in thos e colleges. I believe you private industrialists can find just as capable men in our colleges here to carry on certain specific individualized work as you can find in any university in the east.

Then we want to set up some plan by which we can check all the research work that is going on in private and government laboratories throughout this country to be sure we are not wasting our efforts on something that has already been researched to the final degree; then we want to try to pick out our things in which proper research is not being carried on in other parts of the country and concentrate our efforts and specialize on those particular things. We also hope to allocate research to our various schools with a final pooling of results.

(Mr. Nichols here read a telegram from C. F. Kettering, of the General Motors Research Department in Detroit, Michigan; a letter from Mr. E. R. Weidlein, Director of the Mellon Institute of Industrial Research, and from our area, and a letter from E. L. Little of the National Farm Chemurgic Council, as follows:)

"I RECEIVED YOUR KIND LETTER AND I THINK THE IDEA OF HAVING A RESEARCH COUNCIL IS OF VERY GREAT IMPORTANCE. I WISH I COULD EMPHASIZE BY WORDS WHAT I .REALLY HAVE IN MIND; IF WE CAN GET A COMPLETE UNDERSTANDING OF THE PROBLEMS THAT WILL FACE US, IN THE POST WAR, AND THEN GET MANAGEMENT TO APPRECIATE THE DIFFICULTY OF STARTING NEW PROJECTS, WE WILL HAVE MADE A GREAT CONTRIBUTION TOWARD THE FUTURE OF OUR COUNTRY. I THINK RESEARCH GROUPS IF THEY DO NOTHING MORE THAN GET IT CLEARLY IN MIND OF WHAT THE PROBLEMS ARE, ENTIRELY APART, FROM THE TECHNICAL JOB. WE ALWAYS THINK OF RESEARCH HERE AS BEING ABOUT 50 PERCENT TECHNOLOGICAL AND 50 PERCENT PSYCHOLOGICAL. RESEARCH GROUPS CAN DO JOINTLY MUCH OF THE PSYCHOLOGICAL WORK AND AGREE ON AN OUTLINE OF THE TECHNICAL PROBLEMS. THEN OF COURSE EACH ONE HAS TO BE WORKED OUT. WE DON'T KNOW VERY MUCH ABOUT ANYTHING, AND THEREFORE WE SHOULD BE TAKING LONG VIEWS NOW, BECAUSE IT IS SO EASY TO STOP AND EXPLOIT EACH INDIVIDUAL STEP BEFORE THE NEXT ONE IS

STARTED, BUT IF YOU HAVE A LONG RANGE ON THESE WE BECOME AUTOMATICALLY MORE PROGRESSIVE. SOME OF THESE DAYS I HOPE I CAN SIT IN SOME OF YOUR FUTURE MEETINGS.' C. F. KETTERING GENERAL MOTORS RESEARCH, DETROIT, MICHIGAN"

"MELLON INSTITUTE OF INDUSTRIAL RESEARCH
UNIVERSITY OF PITTSBURGH

Pittsburgh, Pa.
June 4, 1943

Mr. J. C. Nichols
J. C. Nichols Investment Company
310 Ward Parkway
Kansas City, Mo.

Dear Clyde:

I recall only too well our numerous conferences in Washington on the possibilities of aiding the middle western states through well organized research organizations.

I was very much interested in the conference you have scheduled for this coming week in Kansas City to bring together research men from various educational institutions in the middle west to discuss the value of cooperative research. Tremendous progress can be made by such groups, provided everyone works together, and an example of such progress is demonstrated in the efforts of the scientific men who have been cooperating in establishing the synthetic rubber industry in this country. The problems are so many and so diversified that there is plenty of opportunity for men trained in every branch of chemistry, physics, and biology to take part in the program.

A composite geological survey map should help to point out these particular problems and enable you to tackle the most important and promising ones in the early stages of the work.

If such an organization is properly established, I am quite certain that it will pay big dividents to the middle western states, and I hope to join you in some future conference.

Wishing you every success, I am

Sincerely yours,

/s/ ED

E. R. WEIDLEIN, Director"

"NATIONAL FARM CHEMURGIC COUNCIL

50 WEST BROAD TOWER

COLUMBUS, OHIO

June 4, 1943

Mr. J. C. Nichols
J. C. Nichols Investment Company
310 Ward Parkway, Country Club Plaza
Kansas City, Missouri

Dear Mr. Nichols:

The meeting of research men of six middle western states is of great interest to the National Farm Chemurgic Council. It should have outstanding value for the further development of the industrial utilization of its agricultural products.

There is much to be gained by securing cooperation among research workers within a given area. Such cooperation avoids the waste of precious personnel and duplication of work and greatly increases the efectiveness of the work undertaken. The incentive of such a group working together greatly accelerates the compilation of basic material.

Research lends itself to work on the frontiers of human knowledge and achievement-- it deals with marginal, unsolved problems; unclosed gaps in our thinking. It seeks through understanding and control to create new things for better living. An analysis of the results obtained always reveal that no-one has ever lost anything through research and that the results have added materially to the advancement of human welfare.

The writer for a number of years has been concerned with the further industrial utilization of agricultural wastes through application of scientific research. Through this research new wealth, new opportunities, new industries, and new employment have been created. Everyone has gained and no-one has lost through these developments.

A striking example is research work with castor beans. For many years plant geneticists have studied a non-popping variety of castor bean, making possible its successful cultivation. Research scientists can take castor oil, a slow drying oil, and through a process of dehydration change it into a quick drying oil. Without this our war effort would be greatly hampered due to lack of quick drying oil imports from Japan and China. Further studies reveal that castor oil is an excellent lubricant for airplanes - it does not congeal at subzero temperatures. It is used in the recoil mechanisms of guns and for many other uses for the successful

prosecution of the war.

This is only one of a very large number of new products providing basic materials for our war effort and for continuation of our civilian welfare.

New frontiers are being opened through research and it is most encouraging that the group assembled tonight are to participate in this progress.

I wish to extend the facilities of the National Farm Chemurgic Council and its Research Division to assist in this work.

Very sincerely yours,

/s/ E. C. LITTLE

Ernest L. Little
Managing Director"

MR. NICHOLS: When you stop to consider that today more than 200 products are made from corn; 300 from soybeans; corncobs, oat hulls and straw are being made into plastics, casein into fabrics (the old family cow may soon be clothing as well as feeding us); cotton into highways, and in fact, future houses may be built from our gypsum beds; silica sands or farm waste/products; plastics ten times as strong as steel from farm products; 150,000 chemical compounds from coal, oil and gas; fabrics from raw farm products, coal, rock, oil and gas; nylon machinery bearings from cellulose, stronger than steel; synthetic rubber superior to natural rubber from our raw materials of the Middle West; a multitude of products from livestock by-products; ;medicinal and human food from our cereal grasses; much needed fertilizers shipped to us from afar, you get some idea of the importance of this conference.

Let us ruralize industry - let us stop our rapid decline in population and the drainage of our young men to eastern and west coast industries. Perhaps we can grow most of the parts of our automobiles from

our soil as Henry Ford has so well said; let us have no closed economy for the middle west; let us have no economic dust bowl.

Great things are in the offing today - let us not be sleeping when our opportunity comes, particularly in the Post-war period. After all, the Middle West has a rightful place in the industrial future of America, and to that end I have called this meeting with the financial aid of several good Kansas Citians interested in our whole area.

DR. CONDRA: Mr. Nichols, I want to make a motion. I believe that those who have been invited from the colleges and universities and other places to meet with you in Kansas City, under your direction, accept your views and your challenge. We appreciate the entertainment given us by these business men, whatever their relations be here at Kansas City, and I make this motion if someone will second it, to extent to you, Mr. Nichols, our thanks for being invited and for all these things you have done and we pledge you cooperation, you and your associates here at Kansas City.

(The motion of Dr. Condra was seconded and unanimously carried).

MR. NICHOLS: Just to tie local industrial research into school research, I am now going to call on Dr. W. R. Graham of the Cerophile Laboratories. He will tell us something about medicinal and food products from cereal grasses.

DR. GRAHAM: We are probably the forgotten men in agriculture. Why are we interested in grasses? We are tonight thinking about the

natural resources of these middle western states. Take the natural cereal grasses, wheat, oats, barley, without any further growing of material they are producing about 25 million tons of material. Mr. Smith and Mr. Small, who have been of great assistance to us in our production will say that 25 million tons has only scratched the surface.

I will take you back to considering grass in relation to milk. Milk is about 87 percent water. Grass, when it is cut at the stage at which it is at the height of its biological value is 87 percent water. The composition of these two materials is about the same, the amount of flavin, the amount of B-1, the amount of the various members of the B complex we have here a tremendous potential of which this part of the country is the center of the nation, first toward feeding our animals and second toward feeding ourselves. Twenty-five million tons of this material would give the complete vitamin requirements of vitamins A. C. E. and K for one and one-half billions of persons per annum; it would also supply the vitamin B complex requirements of 20 percent at the normal level for the same number of people.

In our research work we have not gotten very far with it. We need a lot of help, we need it from the engineers and from the chemists in the field and from the agricultural people. Twenty-five million tons of dry material is a tremendous potential wealth, but you must be able to maintain the vitamins for feeding or for food in this 25 million tons.

We go from feed which has been the big use of this material to food. None of us think very highly of having a grass salad or having grass in our diet, but we have recently developed a form of material through which practically all grasses can be put together and has all of the vitamins as far as we know of those values that are found and

used every day by our animals.

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MR. NICHOLS: We now ask W. D. Small, of Neodesha, Kansas, who is operating twenty-two dehydrating plants, to say something.

MR. SMALL: My experience with dehydration dates back to 1933. At that time we established our first unit at Neodesha. Today we are operating twenty-two units at sixteen different locations in Oklahoma, Kansas and Missouri.

The things that we have not learned about dehydration of course are causing us a lot more difficulty than what little we have learned. We have found coal to be very practical for use in dehydration. About 50 percent of our product is sold on a guaranteed vitamin A or carotin basis. We find we have an abundance of carotin at the time the material is dehydrated, but to retain this the only method that we have found to-date has been through cold storage by which we have held it up to 90 percent of the carotin in alfalfa but we find also that some of the grass placed in cold storage will lose 50 or 60 percent while others will lose only 5 or 10 percent. This is the thing we need a lot of help on from research men. Whether it is traceable back to soil conditions, fertilication of soil, or what, we are not able to tell definitely, but the colleges in the various states have been very helpful in giving us some information that has been valuable, however, we feel we have a great deal more help in our program, and here is a new industry applicable to our smaller towns.

MR. NICHOLS: I ask J. W. Clarke, Vice-president of the Cook Paint & Varnish Company to tell you something about the oils they are using to

take the place of the tung oils and a lot of other oils that have been cut off since the war.

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MR. CLARKE: We used to make paint out of natural resins and imported oils. The natural oils were from the Congo, the East Indies, the shellac oil from China, other oils from Japan and other oils from Brazil. We used to use lots of imported products. The natural materials in oils that we are having to use today, since Burma Road was closed a year ago and no tung oil comes into this country, are linseed oil, soy bean oil, which is excellent for color retention and castor oil. We can also use in paint products, if we have enough glycerine to go with it, corn oil or peanut oil.

One thing I might tell you that is of interest, we have sold lots of finishes to go on the inside of food cans. If the inside of a can of corn is not coated with varnish the sulphur in the corn will work with the metal in the can and get dark spots in the corn. I don't know, I guess it is edible, but it affects the appearance and affects the taste, and we like the corn to taste fresh, so therefore we worked out coatings for that and meat products. In the case of the corn cans we pigment that can with zinc oxide which is not poisonous and does not even look bad.

We are short on oil and I am sure that there are many products from which oil would be obtainable if we knew more about it. We are ready to use those products whenever they are discovered. Agriculture in our area can play an important part in our post-war program.

MR. NICHOLS: I ask N. N. Dalton of Kansas City if he won't add a word on the subject of oils and glycerine from agricultural products in our region.

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DR. DALTON: Mr. Chairman, distinguished guests. The subject of glycerine is very prosaic. Glycerine, which is so important is also an agricultural product and glycerine can only be obtained from fats and the fact that you cannot take the glycerine out of the fats and still have them edible, leadd to the phrase "Which would you rather have, bullets or butter". There are somewhere around 200 million pounds of fats here; they produce about 15 million pounds of glycerine.

People do not realize the market that agriculture has in the soap industry. The lowly castor bean has fallen into discredit although the rainfall in this area is particularly conducive for the growth of the castor bean. In the past we have seen sunflower seed oil and flaxseed oil brought into Kansas City to make soap, from other parts of the country. With all our agricultural resources here we do not know how fortunate we are.

This meeting here for two or three days is one of the most constructive meetings ever held in Kansas City, and a vote of thanks is due the chairman of this meeting for holding it and getting all these lines together for coordination of research. Again I say that the resources here, with a smart man who has raw materials, if he will try to make something out of those raw materials he can sell at a profit. We have to be realistic about it.

All I can say is we welcome all the colleges and the research talent here tonight and if this meeting follows the course of the object-

ives it has started out to follow, we will find we have a coordination of research that will produce results for this area. Certainly tomorrow may open opportunities, unknown today.

MR. NICHOLS: I ask Walter Millsom, Vice-president of the Dickey Clay Products Company to say a word about the future use of clays in our area.

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MR. MILLSOM: The history of clay manufacturing dates back further than any other industry, I think, with the exception of agriculture. We do not think of clay manufacturing in the modern day and with the modern idea of plastic, but nevertheless the majority of the clay products that are made today are plastic and are made from plastic. This middle western area is very rich in clay. There has been very little development in clay manufacturing through the areas represented here today with the exception of the fire brick and refractory industry and the heavy clay products such as brick, tile and clay pipe which is made by the company I represent.

At the present time we are engaged, with a group of other manufacturers who make clay pipe and kindred products in two things that we think are very important. One of them is block which will be used for radiant heating or cooling of rooms or buildings, particularly in small houses. This block is a load bearing block which will be used on the floor, in side walls and possibly in the ceiling and by passing the cool air or the hot air through it will air condition the air in the room. It is not a new thing, it has been in use in Europe for many years, but there is not a great deal of scientific knowledge on it at the present time

and we are getting all the information now, believing there will be a big possibility for the use of this block in the post-war period, particularly in home construction.

The other thing that we are working on with a group of manufacturers of clay pipe is a clay pipe which can be used under high pressure to convey oil or other liquids or gases which will replace critical materials in that use. This work is being done at one of the eastern universities and I mention this merely because our chairman has had something to say about research people going down to the eastern universities instead of having it done here in the Middle West. We think there is a lot of possibility in it and the work on it is progressing very satisfactorily, and of course clays have many more potentialities.

MR. NICHOLS: I ask Joe Stephens, vice-president of Gustin-Bacon Manufacturing Company to tell us a little bit about silica sands in glass products.

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MR. STEPHENS: My subject is Potentialities of Glass Products Manufacture. The extensive publicity given to the development of many new plastic materials during the past twenty years and the very rapid adaptation within the same period of these materials to products having wide public use have served to create the impression that the plastic art itself is of recent birth.

The use of cellulose thermo-plastics, cellulose nitrate (Celluloid) and Cellulose Acetate (Pyralin) and thermo-setting rubber and other resins antedate the present century. Glass, a true plastic, was discovered, manufactured and adapted to extensive use long before the Roman Empire.

It may therefore be regarded as the first plastic to make a major contribution to civilization.

The molding and blowing of glass is a very old industry. American inventions introduced largely the mechanical methods of molding, blowing and rolling glass products and the attendent much lower costs of manufacture which made widespread use of the material possible.

Development and perfection of methods for the production of glass in fiber or filament form during very recent years has expanded the uses to which glass may be put to such an extent as to give the glass making industry an almost unlimited horison. During the past ten years sales of Fiberglas products have advanced from nothing to many millions of dollars per year with the demand for products already on the market far from sated.

Since Silica and the other ingredients of glass are available in relatively pure state, the chemical composition of the base material can be closely controlled. As compared to other forms of mineral wools used for insulation or as acoustical material and which are processed from native rock, slag or chat, glass wool can be much easier freed from harmful impurities such as sulphur or alkalies that attack continguous metal components of an assembly or structure. The same feasible control of chemical constituency makes possible the production of long or continuous fibers capable of being felted into sheets, blankets or boards that are structurally stable or spun, twisted or woven by the usual textile methods and machinery.

The coarser glass fibers are produced by extrusion through multiple orifice dies. The minute openings in the die are platinum bushed and electrically heated. Thermostatic control of the temperature of the bushings keeps the glass at oven temperature and maintains dimensional cons-

tancy of the openings. In the production of finer fibers, from one to three microns in diameter, glass marbles are first made from glass fluxed in gas fired ovens and these marbles sorted free from bubbles and visible foreign matter. The marbles are then fluxed in small electric ovens, extruded and drawn down to desired diameter while yet at plastic temperature by elongating the fiber at pull away speeds faster than rate of delivery from the extruder. The glass contained in the small marble is sufficient for hundreds of miles of fiber.

While common forms of glass are normally regarded as being quite stable chemically, the tendency of a given volume of glass to react is amazingly increased when it is in fine fiber form as the simple result of the increased surface area open to chemical attack. For this reason glass that is alkali free is used for nearly all types of Fiberglas. Soda-lime glass has been found unsuitable and the formulas used in Calcium-Boron and other glass yield low co-efficients of expansion.

Glass fibers are very smooth. They can be processed crimped as well as straight but thus far not hirsute or notched as to surface. Despite the smoothness of the fiber there is considerable friction between engaged surfaces of the fibers as a result of what, for want of a better name has been termed the property of cold fluxing in friction.

Present large uses for Fiberglas has been found in: Thermal Insulation for buildings, railroad refrigerator and tank cars, passenger coaches, trucks, tanks and aircraft; electrical insulating tapes, tubings and sheet; air, gas and liquid filters, woven filter cloth; various textile forms including shower curtains, reflecting glass cloth shields for flare parachutes, fire-proof curtains, etc.

In determination of suitable locations for manufacturing Fiberglas products about the same considerations apply as to other more common

forms of glass manufacture; abundant and economical supplies of gas and electricity; proximity of supply of silica sand of high purity; proximity of market for finished products.

Recent investigations have disclosed in Arkansas and Missouri supplies of Silica sand of requisite fineness and composition. Other nearby states doubtless also have suitable deposits.

The supply of natural gas in this area is not surpassed by that in any other. Supply of electric power is sufficient. Fiberglas products are of themselves low in ratio of weight to dollar value, but requirements as to methods of packing for shipment tend to offset this. With further progress in design of smaller continuous type ovens expected the penalty on decentralization of large scale operations now established will be considerably reduced and location of complete manufacturing units near markets favored.

MR. NICHOLS: Joe, that is very fine. Now will Dr. Willard Hoehn, Assistant Director of Research of the George A. Breon Company, tell us something about livestock bile for medicinal uses?

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DR. HOEHN: I am going to begin telling you about bile by telling a little story. In 1924 a company in Germany found it could make products from bile which were very beneficial for medicine and they sold this product not only in Europe, the British Isles and in Africa but even in the United States, in fact in world trade, but they didn't have a very good supply of bile in Europe so they bought the bile from Argentine and they would bring the produce up from Argentine and work it up in Germany and sell it over here. About 3 years ago things looked as though we were going

to accept this product pretty well and companies in this country got interested in it, too, and they went to Argentine and got the bile while right out here in Kansas City at the stockyards we have quite an enormous supply of bile. I have the figures for the last three months of 1942 on the actual kill and there is something like 100,000 cattle per month, each supplying about 8/10ths of one pound of bile. If you figure that up that is about 528 tons a month and at the present time, at the present rate you can buy that for about $42,000.00. That is pretty cheap.

Let us take that and as we used to say "All Gaul is divided into three parts". Well, we will divide it into three products. We will save the choline acid out of that and will obtain about 10 percent on that. We will sell that and we will find that is valued at about $69,000.00. That is not very much either. We will convert that into this product hydrochloric acid and we will sell that and that will be worth about $212,000. Then let us get the third product, that is oxalic acid and we will probably get about 2 percent of that and if we take it even at 1 percent we will have about $105,000.00 worth of this oxalic acid. We figured that all up and that is not really a good deal of money, about a half million dollars of value but that is just one place, where about 110,000 cattle are being killed per month and we have similar areas at Omaha and St. Louis and I am sure there are quite a few areas of that type.

We have at the present time about ten groups in the United States and Canada working on a very vital problem which if solved, and it looks as if it has been solved now, will provide us with a compound which will aid us in combating heart failure, and if we can figure this out as to what can be obtained from these bile acids, at a very low figure it will run something like 150 million dollars a year and that is just from the

plant production of bile in this section.

Those are just the figures of day dreaming but we need cooperation. We also need research done in the various universities to cooperate with us.

MR. NICHOLS: Dr. Hoehn, you are a pioneer. I ask Bob Mehornay, Vice-President of the 10th Federal Reserve Bank District to give you a little short statement of the willingness and readiness of the Federal Reserve Bank to cooperate with the research efforts in this section. Bob worked for a year in Washington to promote business for small plants and did a grand job.

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MR. MEHORNAY: I hope that this sordid note of money will not be too disturbing. If the Arkansas fellows will secede from St. Louis we will accept them here in the 10th Federal Reserve district and they will be included in our program which is under way. We have always had a good research department in the hands of able people, but in view of the tremendous progress which is being made and which will be made in this area we are extending that department and dividing it into three divisions and will have in each, a man whose name and reputation will be nationally accepted as an authority in his line.

Of necessity our research must be restricted to money and monetary matters; nevertheless our departments will be one of strictly fiscal matters, agricultural economics and one of industrial economics.

We offer you at any point in this district the facilities of what we are confident is and will develop even more to be an outstanding economic research department by the Federal Reserve district in which you live under

the very able general direction of Judge Leedy, the President of our bank.

(At Mr. Nichols request Mr. Elmer Pierson of the Vendo Company made a demonstration of certain electrical devices by which an electric fan was started and stopped by sound waves - a result of the Vendo Research Department.)

MR. NICHOLS: Now, I ask Lee Talman, Vice-president of T. W. A. to say a word on research in Aircraft.

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MR. TALMAN: Mr. Nichols and Gentlemen: Mr. Nichols has asked me to prepare a short talk on the importance of air transportation in the future to the Middle West Area. Mr. Nichols, who has done so much to promote aviation for the Middle West, gave me ten days advance notice of this. Ten days is sufficient time to assemble information on almost any talk but is a woefully short time in which to condense a subject of this importance into a short talk. It would be much easier if I might keep you here for four or five hours.

The romance of air transportation is fascinating. It would be an easy matter this evening to regale this audience with romantic stores of what aviation will mean to this generation. Our concept of air transportation is necessarily limited by our past experience. Public speakers today speak glowingly of trips to Europe and vacations in Morocco, few realizing that these things will be actualities in our times. The impact of this great economic force will affect not only the methods of business and pleasure travel, the means by which mail and cargo are moved, but will in themselves change the very pattern of our distribution and manufacturing methods. As our markets and methods show advanced changes, so will manufacturing processes come to adapt themselves to these markets.

It is difficult to describe in detail the potential effects of air transportation upon every line of business. I do urge you in your research and planning to recognize at this time that sound planning must take into account the adjustments in our economic life which will be brought about by air transportation.

Please understand that I do not bring you a fanciful dream that air transportation will within two or three years replace all other modes of transportation. I do not expect this to happen soon! But this new force in our economic life - namely, air transportation - will in itself generate and make possible a considerable movement of men and materials to the end that there will be an enormous increase in the total volume of transportation.

The cities of our great plains are no longer inland cities. They are as much of a port on the ocean of the air as is any city on the shores of this continent. This means that the barriers of geography will no longer limit the development of this area. The airplane will, by necessity, create a greater change in the Middle West than elsewhere.

I shall outline briefly and attempt to classify the research problems which must be met in this area, and elsewhere, in order to realize the full opportunity for the future in aviation. To the extent that the men of this area can contribute to the solution of these problems, so will the leadership of this area grow. For convenience, I have classified these research problems into four general groups:

1. Engineering and technical problems: (Reliability (Payload (Speculation
2. The problems of civic planning.
3. Economic problems.
4. Problems relating to national and international policy.

Some of the principle technical developments which must be solved are:

(a) The airplane as an instrument of transportation has made great progress in rendering increasing reliable service. We still have a long way to go. Uncertain weather still requires the occasional grounding of aircraft in order to maintain our standards of safety. The first major improvement in aeronautics, which I anticipate following the war, will be improved technical systems for blind flying. These will undoubtedly be materially aided by the use of radar and other important inventions developed during this war.

Mr. Ernest R. Breech, President of Bendix Aviation, and manufacturer of equipment of this type, forecasts that within a relatively short period after the war, the necessity for the cancellation of flights on account of weather will have vanished.

(b) The second type of technical improvement will be those which tend to improve the payload of aircraft. These improvements will include design changes, perhaps like the flying wing, engines of vastly increased horsepower, brought about by improved metals and volatile fuels. Instruments will have great improvement through the years.

(c) The third type of technical development will be in the form of the airplane itself in order to achieve greater flexibility of operations. The airplane of the past and the airplane of today has been limited to a degree by certain characteristics of its operation. The airplanes of tomorrow will perform jobs of many different characters. There will be giant aircraft for the hauling of heavy loads over great distances. There will be the smaller and swifter aircraft, faster than anything we have yet known, for the transportation of men, mail and

emergency shipments. I expect to see the commercial development of an airplane somewhat along the lines of the present day helicopter for short hauls. Thus, the specialized development of various types of airplanes will play an important role in enlarging the usefulness of aviation.

The second phase of research problems that is applicable to the development of aviation in the middlewest is the problem of civic planning of airports. Practically every major city is today seeking information as to how it can best plan its airport and community development to fit this pattern for the future. To determine definitely the precise facilities that will be needed by each city and at what date is, of course, impossible. The very uncertainty of the future makes it all the more important for each city to do such planning as it can. It logically follows, I believe, that aviation will go where it is best received and where the facilities for the serving of its business exists. Therefore, to the extent that each of you participate in the civic planning of your own communities, I say to you, that it is almost impossible for you to overplan the aviation needs of your community and to the extent to which you do the job of anticipating those needs, so will your city prosper.

Under the heading of economic problems come those research questions related to routes, frequency of service, economic desirability of large or small aircraft and a host of other problems related to the cost of operation of a given route. A great many cities in the middle west are realising, for the first time, that they are ports on the ocean of the air and are immediately urging the granting of routes from their city to other ports of this air world.

From "Memphis to Moscow" seems to be the motto for those who would today grant routes from everywhere to everywhere. We, in the air trans-

portation business, welcome route expansion as being healthy and logical in the development of our business, but it is readily possible to over-expand the route structure and thereby sacrifice frequency of service.

One major advantage of air transportation is speed. It is correlary to that general proposition, that overall net speed can be achieved in fact only as there is frequency of service. It is not profitable nor economical to move cargoes with great speed if they must wait for hours or days to begin their transportation. To illustrate, specifically, Kansas City may have a sufficient community of interest with one of the larger European cities to justify a three cargo schedule once every five days. If we attempt to set up a route which provides service only between Kansas City and that European town, a load of cargo may conceivably wait for three to five days before it is shipped and then be rushed half-way around the world at great speed. The situation changes appreciably, if we realize that Omaha, Des Moines, Kansas City, St. Louis, and Tulsa may all have cargoes to be dispatched not to one but,to illustrate, five European centers. Thus, by consolidating the traffic between five important European cities and five important cities in the midwest it becomes possible to run schedules twice daily. As a consequence, the merging of traffic and the feeding of business into dispatching centers, becomes even more important to air transportation than in the slower forms of shipment. It follows, therefore, that the question of the determination of routes is an economic problem for specialists. Our solution to this problem must at least, initially, be made out of consideration of the economics of an area and not the economics of single cities.

Similarly, the engineering feasibility of large vs. small airplanes must be tempered by economic consideration. The question of whether it

is more desirable to have 100-passenger airplanes or 50-passenger airplanes rests not solely upon technical considerations but upon economic realities. It may be better in certain instances to have two schedules with 50-passenger capacity each, than one with 100-passenger capacity. We may find that it is economically desirable on certain routes to have one plane with 200-passenger capacity while on others 4 - 50 passenger capacity.

Economics and social progress must keep pace with technical developments. Man made barriers must disappear. The fourth and final problem as related to national and international policies is the position our national government will permit its airlines to operate in the international field. If there is a short-sighted plan advanced that permits foreign lines to develop where our activities will be curtailed, then we may by this restriction be limited to a relatively small area. You have heard and read recently considerable on the subject "Freedom of the Air". This in theory is right but in application must also have freedom of rights to land. There will necessarily have to be a plan of give-and-take with various foreign groups if the United States lines are to have their competitive place in the international picture. These policies are now being molded for their use tomorrow.

Each of these problems, technical, civic, economic and politic present a real challenge to any research group. If I may presume to criticise on much of the research work done in the past, too little time has been spent, once the issue has become clear out, in determining who, when and how is to be responsible for accomplishing the job. Therefore, I submit to you that the genuine research specialist of the future will dedicate himself, not merely to the task of pure research, but, in addition, he must be an economist and statesman in determining how to make his dreams become realities.

The biggest challenge of tomorrow is the one of adapting the standards of scientific research to economic and social problems. The airplane is the vehicle not only for the transportation of men and material but can readily be made the vehicle for conveying research itself into broader fields.

The world has never had enough or good enough transportation. In closing, I want to thank you for the honor and the privilege of having met with you for dinner and for having had your attention. Not ten minutes but three minutes as it turns out. Thank you.

MR. NICHOLS: Thanks, Lee, the Middle West will be close by air to the entire world. Now, we are to have a talk by our good friend, George Oberfell, Head of the Research Department of the Phillips Petroleum Corporation, who will tell you about by-products of oil and gas. He came up especially from Bartlesville to be with us and has been in our sessions all day.

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MR. OBERFELL: My subject is "Cooperation of Industry and Universities in Petroleum Research".

(1) In dealing with all research problems the greatest desideratum is Patience. The greatest of all the research problems is the people who do the research, and in dealing with them Patience is not only a virtue but a necessity. Remeber that the research worker's motto is: "Rome was not built in a day". So the three-hundred- and sixty-six days of a Leap Year when the research department doesn't discover anything are presumably some of the days when Rome was not built.

(2) It is worse than useless to point out to the research depart-

ment that sales are falling, that profit margins are non-existent, and that they haven't turned out a new idea for fifteen years. You can't expect them to be interested in your beastly sordid business. They are scientists, and you can't hurry science. It was precisely to avoid being worried by this sort of nonsence that they became research workers.

(3) If you are going to have a research department at all, go the whole hog and enter into the spirit of the thing. Build a laboratory and place in it a lot of bottles and benches. Then collect a few people from the universities with First Class Honor degrees in Chemistry (They are quite cheap at the summer sales). Turn them loose in the laboratory and leave them. For a few days they will probably wander restlessly round, scratching at the doors and howling. But after a while they will settle down and start using glass tubing and filtering things perfectly happily. And you will be able to show them to visitors, which is a nice thing to be able to do.

(4) It is far better if one needs a quick answer on some technical problem to get a roughly approximate one from old Joe Binks the foreman, who hasn't the disadvantages of a scientific education. Give the research department only Big Long Term Problems and leave the results in trust for your heirs.

Mr. Nichols has requested me to discuss briefly some of the things that may be done to effect further improvement in the cooperative efforts of schools and industry in the field of petroleum research. That the past has been productive is obvious to all of you who have been following recent developments in connection with the war effort. It is probable, however, that few people are cognizant of the important role that painstaking university researches of a fundamental nature have played in the rapid reduc-

tion to practice of new processes and the early commercial development of new products for new uses. Hence, in my brief and hasty review I would like to touch on raw materials, reserves, what has been done, what the future possibilities may be, and finally, how in our opinion industry and university can best proceed to effect further development of these raw materials.

As you know, the petroleum industry has available a tremendous reserve supply of crude oil and natural gas, both of which for the purpose of this paper are referred to as petroleum. Proven reserves of oil are of the order of 20 billion barrels in the United States, while the known reserves of natural gas are conservatively set at 85 trillion cubic feet. This volume of gas, expressed in terms of reserves of power or energy, is equal to some 20 billion barrels of motor fuel. These staggering totals should provide ample reassurance to the chemist and the fuel technologist that an abundant reserve of petroleum raw material is available to draw upon.

Because the discoveries of the last decade have caused the chemist to look upon petroleum not as a particular type of raw material but rather as a source material for the elements carbon and hydrogen, it is obvious to the chemist that the question of reserves is somewhat academic. Thus carbon and hydrogen can be derived from oil shales, soft coals, and even from plant life. All of these become potential source materials for future chemical developments in the hydrocarbon field. Of course, water and air remain our most prolific sources of hydrogen, oxygen and nitrogen, which are used in many chemical reactions.

The dominant products of petroleum subsequent to the kerosene era have been fuels and lubricants. The outlets for chemicals derived from

petroleum, although large from the standpoint of the chemical industry, are small in comparison with our fuel and lubricant markets.

Developments in petroleum refining technology over the past few years have given us fuels with built-in potentialities far in excess of the capacities of present-day engines to utilize such values. Markedly improved lubricants have likewise been developed. Both are the results of a broader knowledge of what is required and a chemical knowledge of how to attain the desired results. The extension of the cracking process and the widespread adoption of some of the recent developments which you have read so much about in the daily press, such as solvent extraction, superfractionation, polymerization, catalytic cracking, alkylation, Isomerization, and similar processes have resulted in enormous volumes of high quality fuels and lubricants that are required for modern warfare. While many announcements of these newer processes have appeared in the daily press, they have not as yet been described in the current technical literature, for the obvious reasons of government secrecy requirements. There are, however, no reasons for assuming at this time that the ultimate in quality of fuels and lubricants has been obtained. The progress of the last few years is mute evidence that it is impossible for anyone to attempt predictions for even as short a space of time as ten or fifteen years. Who, for example, would have had sufficient courage of his convictions to forecast the widespread commercial production of iso-octane, the synthetic fuel material, at the time its properties were first called to the attention of industry by Dr. Graham Edgar? It is a tribute to research and development that the price of $30 per gallon for iso-octane has since been reduced to less than 15¢ per gallon.

The majority of the new processes developed in recent years in the

refining industry have been those based on chemical reactions. Obviously, the introduction of chemical knowledge in refinery technique will have the tendency to further interest the refiners in the manufacture of chemicals. Marked progress has already been made in the manufacture of chemicals from petroleum, and a substantial part of this has been done by companies interested more in chemicals than in petroleum products. Strictly speaking, all compounds are of course chemicals, but the petroleum industry is rapidly beginning to think of chemicals as all of those new products which are not used as fuels or lubricants.

Of chief interest currently in the chemical field is the synthetic rubber development, which at one time called for about one million tons per year, a substantial share of which will be of petroleum origin. Other products now manufactured in appreciable volume from petroleum and natural gas hydrocarbons include the familiar anti-freeze compounds, solvents, explosives, alcohols, glycerine, and a veritable host of derivatives which constitute starting materials for many other chemical products. The viewpoint of chemists on these various developments is that the surface has barely been scratched, and that further researches will bring quick results on the preparation of new and useful chemical derivatives from petroleum raw materials. The possibilities of the new field of synthetic plastics alone offer promise of making all the other petroleum chemical developments to date appear small by comparison.

Lest the impression be left that the chemical field is an unlimited one so far as markets for petroleum and natural gas are concerned, we would like to offer a few comparisons to illustrate how relatively small such outlets generally are for these raw materials. Thus, it was recently

calculated that the entire pre-war annual production of wood alcohol could have been produced from a single gas well of ten million cubic feet daily capacity, if near-perfect conversion efficiencies were obtained. This means that the potential production, if realized, from only one of our larger gas wells would have flooded the market. Similarly, the ethyl alcohol, generally referred to as grain alcohol, which could be prepared from one year's production of ethane, propane and butane, would amount to some 300 million barrels. Also, the butadiene (raw material for synthetic rubber) which could be produced from the butanes annually available in the petroleum industry, could result in a volume of rubber at least five times that consumed in normal times.

The figures just cited serve to illustrate the relative insignificance of the volume of chemical outlets as compared with the normal fuel and lubricant markets. These small volumes, however, are no reflection of the income producing possibilities of chemical manufacture to industry and labor, for the reason that investment, operating costs and sales prices are comparatively high.

With this presentation as a background, I now wish to discuss the organization needed to guide a new process into successful commercial operation. It takes considerable manpower and time to develop new products from the test tube to final commercial utilization. The universities have been doing and are doing much with research and development, and they are to be congratulated for their accomplishments. They serve as a starting point for practically all of our developments, because we are depending upon them for the first and most important requisite -- technical manpower.

It takes a fully integrated organization, functioning under one head or manager, or at least under one management, to promptly and efficiently develop new processes. The successful commercial organization needs to be composed of a large number and a variety of highly skilled groups working together to accomplish the commonly-desired result. This includes not only the research engineers but also market analysts, experts in the field of patent and civil law, engineers to design and operate the plants, sales promotion experts, accountants, and a host of other trained and skilled men.

After the plant is built and put into operation by the engineers, it is not a commercial success until the product can be sold at a profit. To accomplish this, a competent sales promotion program is necessary. Along with this, accounting and bookkeeping are essential for the purpose of knowing the financial status of the process at the end of any given period. Any process that is developed should be preceded by a thorough study of the patent situation. Sometimes the amount of royalty to be paid determines whether a process is economical. Hense, the importance of patent rights becomes obvious.

At this point, I should like to make one suggestion to you university men, and that is that a practice be made of training students in the significance of patents along with their technical training. It is our experience in industry that recent graduates have not been impressed with the necessity for adequate patent protection of the results of their research work.

Now in order to show how the universities and colleges can cooperate with industry in the promotion of new and better products, some specific examples will be given. In the latter part of 1942 our company

put into operation the first large commercial plant employing the new hydrofluoric acid alkylation process for the production of 100-octane aviation gasoline blending agent. The design of this plant was based upon discoveries made some years ago by the Phillips Research Department, and the plant was designed and built by the Company's engineers. It so happened that certain basic information was incomplete. For example, data were not available on such desirable but not absolutely essential items as (1) the solubility of the acid in various hydrocarbons and their mixtures, and (2) the specific heat of the acid, its latent heat of vaporization and its degree of association in the gaseous state under the temperatures and pressures used in the commercial process.

We did not have the time and manpower to secure this information, and of course had to proceed with the design and operation of the plant without the benefit of such information. The universities are well qualified and have the facilities to obtain such basic data and to do fundamental research in the broad sence. They are also well qualified to originate and perfect various analytical methods and obtain experimental data on chemical and physical properties much desired in the design and operation of plants embodying new processes.

I might cite another example. We are now designing a plant that embodies a new process for the manufacture of a product used in our war efforts. I am not at liberty to disclose the nature of the product nor the process, but I can freely confess that we are going to build this plant without the benefit of some useful but not entirely essential information. In our design we will provide a factor of safety to allow for probable inaccuracies in our estimates. Within our Research Department we call these factors of safety "ignorance factors", and that is what they really

are. Usually the use of an ignorance factor proves to be much more expensive than the cost of obtaining the desired information. The universities can remove many of these ignorance factors by carrying on the desired research work. You have done a most remarkable job in this connection in the past, but you should attempt to redouble your efforts in the future.

I have already mentioned manpower, but in closing I wish to emphasize to you men just how short industry is of technically trained manpower. We need various classes of technical men, including chemists, physicists, etc. We should jointly assemble our efforts to impress upon all interested parties the necessity for the deferment of technical men now engaged in this important war work. Without these men, munitions of war will in fact come "too little and too late" and any post-war planning which we now do will have been in vain.

MR. NICHOLS: Thanks, George, that was a great speech, and I am pleased to tell Boots Adams and Frank Phillips we all appreciate your immense help in this whole conference, and we know of no company doing more to promote a greater use of our raw materials than the Phillips Petroleum Corporation under your capable, daring research direction.

Now we have one more speaker on our program who in the World War developed mustard gas, got it out a little too late to be used, and as head of research for Union Carbon and Carbide Company since that time has made 187 other products from his research relating to mustard gases. Ernest has spent a great deal of time at the many plants of Union Carbide in Europe and was in Europe when the war broke out, was headed for Germany but the war came too quick for him.

He was for over two years head of the Defense Chemical Division down in Washington. He, as a real westerner, has made the trip here to be with

us and he is deeply interested in research development for our area. Dr. Ernest Reid.

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DR. ERNEST REID: I haven't any prepared paper because I was busy on the farms when Clyde called me and said he wanted me to come to Kansas City, so since I haven't anything specific to say, it means I can probably run on about two hours.

Clyde, I know, perhaps better than anyone, the uphill, discouraging road you travelled; the determined fight you made -- almost singlehanded and alone for such a long time in Washington to convince the defense group that it was wise and sound to place defense plants in the Middle West. All the breaks were then against you -- the cards stacked -- eastern industrialists could not and would not see it, and against tremendous odds you did a grand job for the middle west and the entire nation.

I would like to say to you men who are not technical men that chemicals are often not appreciated either in a war effort or in civilian use. For example, it requires over two thousand chemicals to build a battleship, it requires over two hundred to build a tank and it requires almost three hundred to build the automobile you drive. Explosives are chemical products produced by definite chemical reactions. If you want to carry it to an extreme, everything that you do, handle and wear, uses chemicals in some manner or form. Some of the clothing you have on are chemical products, others have been treated with chemicals before you get them and that is why we have stressed the chemical industry for the Middle West because the Middle West has all of the raw products to produce practically all chemicals.

From agricultural products, petroleum products, coal, we can produce

today over 200 thousand chemical products. Of course, most of them are not worth producing. The list that are used commercially, of course, is comparatively small.

I was born and raised on a farm in Kansas; I went to Southwestern College; I went into chemistry but I had to go east to follow the profession that I wanted and it seems to me that with all the raw materials available in the Middle West that our young men who want to be engineers and chemists should be able to follow their trade in the Middle West and by the Middle-West I do not mean just Kansas. I mean the adjoining states because anything that helps Nebraska helps Kansas, Arkansas, Iowa, Oklahoma and Missouri. That is why I believe, Clyde, we should have, in the Middle West a Mid-west Research Council and possibly a Mid-west Engineering Council.

I think I know research men pretty well. I was one myself one day; I have handled a good many of them and I say research men are a peculiar breed of chaps. Research men are not made, they are born. You cannot make a research man. He either is or isn't. It is like a salesman. You have no doubt handled a good many salesmen; I think with all sales training courses that a man is either a salesman or he isn't and if he isn't you can't do anything about it. This job of selling research is really a selling job. It doesn't mean that a research man or a chemist is not a salesman. He can be.

Back in 1925 or 1926 when I was manager of a chemical plant in West Virginia in which we were producing various chemicals from natural gas, I found it was easy to produce them but it was very difficult to sell them because we were producing products at that time which were unknown to industry. To go out and talk to a fellow about ethyl chloride or ethylene glycol, he didn't know what we were talking about. He didn't know what they

were good for and in many cases neither did we. So we found it necessary to establish a sales development laboratory with research men who could go out to the manufacturer and show him and tell him how to use it. That was a selling job and from that grew a sales department headed by a Ph.D. In chemistry, a research man, and every man in the sales department was a chemist. He came out of the laboratory. That was a new idea at that time; now most of the chemical companies have adopted it.

There are still many people in this country who believe that Germany is ahead of this country in chemical manufacture and technology. Having spent almost four years in Europe and having been in almost every chemical plant in Germany as well as the rest of Europe I can tell you from first hand knowledge that is not so. The United States leads the world in chemical manufacture and discovery. In Europe the German is not the best technical man and it was a surprise to me to learn that the Czech was the finest engineer and technical man of Europe and I think it is extremely unfortunate that these people are now in subjugation. As a matter of fact, I helped a good many of the technical men and engineers of Czecho-Slovakia get to this country. The finest industrial plants of Europe were in Czecho-Slovakia. That, again, was a surprise to me; I am sure it is a surprise to many of you.

It seems to me that in addition to these meetings we are having today, which are extremely useful, that it should not be permitted to go on just a meeting, but that there should be something definite come out of it, a formation of a research council or an engineering council and a group of you business men who can help and guide. It should comprise both school men and private research men.

We heard a paper today on the Research Institute of Oklahoma. As

near as I could determine it was patterned pretty much after the Mellon Institute in Pennsylvania. As many of you know, Robert Kennedy Duncan used to be a professor at the University of Kansas; he had the idea of research; he couldn't get anyplace out here and unfortunately Kansas let him get away. He went to Pittsburgh, he interested Mr. Mellon and he got the money to back him. As the result you have the Mellon Institute as a going concern, which has a greater reputation in Europe than it has in the United States. But, the idea is fundamental and because the Mid-west missed one time, is no reason for them to miss it again and it seems to me that this meeting today can be the foundation for a Mid-west research institute of the future. It takes money to do it and lots of money, but by organizing a Mid-west research council you can prevent duplication in your universities, you can save money. That does not mean that if you can interest a corporation or company in your results that duplication is not a fine and sound proposition; it is done in the larger corporations.

We saw here today the geological map and heard a good deal about geological surveys. I could tell you from experience that the geological map that was gotten out by Kansas is one that appeals to business men more than any other, if you can understand it, and I have suggested to Clyde Nichols that an attempt should be made to get out a composite geological map such as the one we saw here of Kansas today covering the Mid-west area and distribute that map to various manufacturing companies throughout the United States which should be interested.

Now, this, as I say, is a selling job. You cannot sell manufacturing companies by ballyhoo. You must have facts and you must be able to back those facts up. During the two years and nine months I

spent in Washington we had many reports of the Middle West wanting plants here, there and the other place, and I was amazed at some of the reports that came in as to why they wanted plants in various places. They were all ballyhoo, nothing else. That doesn't get plants; you must have facts.

The reports on your research work should be factual and I have read a number of reports from out here as well as from other places in which they give the results of a small amount of experimental work and the rest of it was all filling up paper with print. You must not assume that because you very much want a plant that you are going to get it because you want it. There must be some advantage to the manufacturer in coming to the Middle West and God knows you have plenty of advantages if you prove it to him, but you have got to sell him on the idea.

Advertising is one way to interest people, through the engineering journals, by interesting the railroads. They should be interested of course in freight. I have heard a number of railroad officials during my time who have said that if we could go ahead with the chemical industry or any type of industry in the Middle West that they would consider train load rates and that is what we have got to have in this area in order to serve the eastern markets or the center of the population. You can get it today from the Gulf Coast because you have water transportation as a competitor and we can get train load rates from Texas cities, and we cannot do it from Kansas, Nebraska, Oklahoma, or Missouri.

I would like to mention several things that I have thought of in the past two months that I have been spending on the farms that we might do in agricultural products. I am very much interested in wheat because we raise a lot. Before I left Kansas I spent a year and a half on research

on wheat and flour and one thing that always intrigued me was the gluten in wheat and I am still not convinced that the gluten of wheat, if treated properly chemically and physically, cannot have some great industrial use. I believe it can.

I might say that the best bread I ever ate was in Ireland and I was so interested in it I inquired where the flour was made and it turned out it was made in a little old water mill, a stone mill. I went up to see the mill. It was the darndest looking thing you ever saw, the stones wobbled, they were dull, needed sharpening. I asked the fellow why he didn't sharpen them, why he didn't straighten them up. He said, "That would spoil my flour". I believe he was right. We have got flour milling down to too fine a point, we have taken the vitamins out, they go out in one stream, no one knows exactly where they go but we are eliminating all the natural vitamins and minerals that nature has put in the wheat. You cannot store whole wheat flour at the present time because we don't know how. I will wager there is some stabilizer that can be put in wheat, ground wheat, whole wheat flour that will keep it fresh and can be stored and that is the subject, it seems to me, for research.

And, I understand that we can raise sunflowers out in this country. A gentleman spoke here a while ago of sunflower oil that we used to import from the Near East. Why can't we develop sunflowers of high oil content in this area and extract the oil? I am told it produces a very fine oil and by proper treatment can produce good varnishes. We are getting established in the soy bean industry, but it is limited to the northeastern part of our area at the present time. It seems to me that possibly a strain could be developed that could go further west. We have the grain sorghums and kaffirs that can grow in most any part of the country. There is work

going on now on the utilization of the starch of the grain sorghums; that should go a little further and include not only the starches and the syrup for human consumption but also for industrial purposes.

We import huge quantities of tapioca paste. We should be able to make some sort of starch in this country that is as good or better than tapioca for paste purposes.

I have always been intrigued by the milkweed, as I imagine many of you have been on farms have been intrigued. We know that the Russians have developed a strain of milkweed that will produce a good strain of latex for rubber. It seems to me that is another thing that might be developed because milkweed certainly grows without much trouble out here.

There are other weeds that might be looked into, I don't know which ones, but certainly they should be considered.

We have heard something today about rocks and various mineral rocks of this area. As many of you know there has been developed a transparent film from rock, threads from rock. That is in its initial stage but it is extremely intriguing and especially with gypsum, as we have here, both in Kansas and in Oklahoma, and Nebraska, to produce a strong transparent film, waterproof, absolutely insoluble, almost impervious, as ordinary elastic. It sounds fantastic but it has been done in the laboratories with certain types of rock in the east and I say it can be done with the abundant rocks we have in the Middle West, but it is going to take a lot of research work to do it.

Some of the men today seemed to think that this idea of a Mid-west Research Council is new. It is not. There is a New England Research Council of which Dr. Lawrence Bass, former Assistant Director of the Mellon Institute is head. Because the New England states decided that their

future was in research; they were losing population, the same as we are out here, so they got together and set up this New England Research Council with Dr. Bass to head it and it seems to me that if New England don't beat us we better get busy, Clyde.

There was some discussion today about salt, referring to the electrolytic method. At the present time there are three methods being worked on other than the electrolytic to produce caustic soda and chlorine from salt. Up to the present time only one of these methods appears to be very promising but they are still too much in the laboratory stage to be certain that they won't work and if they work, and I believe at least one of them will, they will prove more economic than the electrolytic processes and they should be applicable to this section because with the natural gas we have cheap heat and that is what you need in the processes.

We will hear tomorrow something about fertilizer and certainly low cost fertilizer is one of the greatest needs of this part of the country, although I admit it is very difficult to convince the farmers that they need fertilizer, especially out in the central and western parts of the state. I was telling some of the men today that on one of my farms we had some alfalfa which was in pretty bad shape. I told our tenant to plow it up and go into town and buy a hundred pounds of potash and put it on and re-plow the alfalfa. All the neighbors think I am crazy but they have to come to it. I know of pieces of ground out there that have grown nothing but wheat for 27 years. We can't keep that up. It is an educational process and I think if Kenneth Spencer is able to go ahead with his ammonia fertilizer in his plant the first thing he has to do is educate the farmer and that is a tough, long job.

We heard something about chemicals from natural gas. I think I

know a little about that; I spent 27 years on it and I will say that before I left Carbide and Carbon that we had in the laboratory stage, or some little beyond that, over 800 chemicals that were produced from natural gas, and when I say natural gas, I mean the constituents of natural gas, chiefly ethane, propane and butadiene which can be cracked to the unsaturated product of ethylene and butadin. In chemical manufacture, and I do not mean the fine chemicals, I mean tank car chemicals, we were three years ago producing 187, in fine chemicals we had over 200, all using ethane, propane and butadiene from natural gas. Those same products can be produced from oil - they can be produced from coal and research is going on to produce those unsaturated products from coal which is diametrically opposed to the work on coal up to the present time, which has been to produce gasoline and oil from coal. We heard something about that today. I spent almost a week in the Loyeten plant in Germany, in a coal-gasoline plant; it was a half-mile wide and a mile and a half long, a solid plant. Certainly, from a research angle, this country should be doing research along that line. We certainly should, if only from an informational standpoint and at least to keep up with the world; otherwise we may be beaten out some day or pay a tremendous price for their technique.

Another thing that I think a group in the Mid-west should consider, and this is not so much from the viewpoint of the technical man as the manufacturer, and that is to get small manufacturing industries in the small towns. Possibly food processings can be done in certain areas. The manufacturing of foods, the manufacturing of small articles that go into the civilian economy are the things I mean. That is in engineering and financial study. I was going to suggest to Bob Mehornay that in their research in the bank they probably give consideration to something of that

sort and it seems to me that some sort of an organization, a combination of engineers, chemists, and business men of the Middle West should consider these towns and I do not mean the Chamber of Commerce type of stuff, but when you are talking about establishing industry in a small town you have to consider the financial angle.

Then on this matter of development after research. When we talk about the possibility of the future of a Mid-west research institute, that has to go further than the laboratory because no laboratory process is any good until it has been through the pilot plant stage, through the engineering stage, and from the small pilot plant of possibly five or ten gallons a day you must go 20 times that, and that is when the commercial manufacturer comes in. There seems to be some doubt existing here of interesting larger chemical manufacturers in the Middle West. I do not believe that is true; I know they are very much interested. I have been trying to preach this gospel for the last three years to the chemical manufacturers whom I all know and I think they are becoming interested, very much interested, and I think the war is going to increase that interest, providing we of the Middle-West do not let it die.

I would like to close by saying that my experience in Washington, in spite of all the difficulties that were put in the way and the difficulties that the manufacturers had in doing the job they were supposed to do, that they have done a magnificient job; they deserve all the credit in the world; they deserve all the help the Government could give them instead of the hindrances that were put in their way, and when you consider that in two years the manufacturers of this country have built an arsenal such as the world has never dreamed of; that we have built in our country the world's greatest mechanized army both in size and equipment; that we are

building an air force greater than all the other air forces of the world combined, and that we are building a navy greater than all the navies in the world put together; we are building a Merchant Marine bigger than all the others, and a synthetic rubber industry greater than the natural, and at the same time we are trying to maintain the highest standard of living in the world, and it has been and is a magnificient job, and I think that we of the Middle West should be prepared to do everything we can to take advantage of our natural resources, to interest the manufacturers who have done such a magnificient job in our part of the country. Thank you.

MR. NICHOLS: Thank you, Dr. Reid. We all know you are the red-blooded, twofisted type of American it takes to make an industrial pioneer in bringing into the middle west our fair share of our nation's progress.

You have the daring and the vision to tackle our great reservoir of raw materials. I know you feel we have a great opportunity for export trade to Latin America after the war, so, Gentlemen, it must be 'green lights ahead' if we expect to share in the national prosperity which is rightfully ours. We have the finest American born labor in our land, today being skilled in our war plants -- we have a great transportation system comprising all types -- we have the nation's cheapest fuel; and last but not least, we have capable, trained, research in our schools.

Certainly, it is up to the business men of our area to accept your challenge, Ernest -- to build a great Middle West industrial area -- and I know with all your contacts you can and will help us in every way. I know you will all agree with me that the hand on the plow should grasp the hand on the loom; the hand that steers the tractor should clasp the hand of the man in the laboratory; and the mind of the research man should meet the men

in the fields on a common ground.

May I ask our great friend, Ward Gifford, President of the Chamber of Commerce to close this meeting.

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MR. GIFFORD: Mr. Chairman, fellow citizens. The first day of your indoctrination has been pretty strenuous. We have heard a good deal of talk lately about there no longer being any frontiers and therefore a great lack of opportunity for a continuous American prosperity. I believe no one could have sat through these meetings today without realizing that we are here on the edge of a great American frontier. You scientists who are here in conference, you research men, I look upon you as the pathfinders who are going to point the way to a continuous prosperity for us in this part of the country, if you please, a perpetuation of thehigh standard of living to which we are now accustomed and from which we will not depart.

Jim Bridger of Kansas City once pointed the path through the gaunt, naked Rocky Mountains and a great railroad followed in his footsteps to build a great empire. As by-products of his explorations, the discovery of the Great Salt Lake and of the Yellowstone came to us to inherit as real treasures. I see your pathway just as productive in its major result; I am sure these by-products along the way will be just as alluring and I want to pass over the challenge or the insinuation that Dr. Reid made about Chambers of Commerce because I quite agree with him, but I believe you will find Chambers of Commerce of today and organizations of that kind just as intent upon searching out the facts as are you gentlemen. I believe you will find the business men of this community and the other communities with which you are familiar, willing to go even further than that because regard-

less of the facts you gentlemen produce there must be, and I agree with Dr. Reid, some sales engineering to make them acceptable to the communities in which we all live.

I pledge to Dr. Reid and to Mr. Nichols and to you gentlemen the whole-hearted support of the Chamber of Commerce of Kansas City, Missouri, in establishing this Mid-West Research Council, an institution of which I thoroughly approve and most cordially endorse, and I say to you, Mr. Nichols, that whatever your efforts may be along this line, you know, without my saying so publicly, that the Chamber of Commerce is 101 percent behind you in your efforts and in doing this we have no narrow thought of self-acquisitiveness so far as Kansas City, Missouri is concerned, but we have in mind only the thought of this entire area. Kansas City's name, its sentimental name has been and still is "Kansas City, mother of the Mid-west". We wish to continue to be so known and we will contribute our every effort to make this undertaking that has been launched here today a final and conclusive success.

DR. REID: I must say, Mr. Gifford, that of course I did not mean the Kansas City Chamber of Commerce; I am quite sure that it is different than any other.

There is one point I wanted to bring out to the manufacturers who are not too familiar with research. Sometimes they get too enthusiastic. I have gone fishing several times since I have been home. I find that in casting for bass I have to make a lot of casts and sometimes I don't get anything, once in a while I get a big one. In fishing for catfish you have to put on a lot of worms before you get a fish because the turtles take them off and the crawdads. The same way with research. You put out a lot of bait, sometimes it is pretty discouraging and you feel like not

fishing in that hole any longer. But, keep on fishing sometimes you will catch a whopper, so I say to you men who are not too familiar with research, don't expect magic. Research is not magic, it is a lot of hard thinking, it is a lot of hard work, nothing else, and just remember if the research department doesn't come through when you think it should, go fishing and then start thinking about them.

MR. NICHOLS: I want to apologize for not having the time to call on Dr. Roy Cross, who has been a lot of help in bringing this conference here, and who has been sitting with us; and there isn't anybody's help that is more valuable than Dr. Roy Cross.

(Thereupon the meeting adjourned.)

Tuesday, June 8, 1943, 10 o'clock P.M. Hotel Phillips

MR. NICHOLS: We have one more subject we ought to finish; Dean Carson, of Oklahoma University, Head of the College of Engineering, "War Plants and Their Conversion to Post-War Industry".

DR. CARSON: Oklahoma appreciates being invited here. This subject that has been given to me is rather broad and I have no definite ideas about it, I have some general ideas. I think this meeting is an excellent idea; many of you have expressed the same opinion.

My business as an educational administrator is a promotional one to a certain extent, certainly as far as research is concerned. I am closely in touch with the research at the College of Engineering at the University of Oklahoma and I watch it with interest, and I want to say that any man who goes into research can go in more or less with a selfish motive because if he is attacking a problem that should be attacked, he is not only promoting research in industry but he is also promoting himself. We have had many cases where men have spent from 2 to 3 years on a research problem

and gained national recognition and from a job as a member of our staff has jumped to double the salary we could pay him.

Mr. Nichols brought out last night that far too many companies look to the universities and colleges of the east to do research for them. That is very true. About five years ago the American Society of Mechanical Engineers decided to promote an intensive research program on the metering of viscous fluids. It is easy to meter water and oil but when it comes to viscous fluids there are many variables that you just cannot meter in the conventional way so the American Society of Mechanical Engineers, the fluid meters committee, with headquarters in New York decided to go back to an eastern school. I heard about it and a group from Tulsa sent me back east and after arguing for a number of days we convinced them that research could be done in the Middle-West as well as in the north and east. We have completed some 45 thousand runs on this set-up and the American Society of Mechanical Engineers has spent I think 32 thousand dollars on the set-up that we designed, that is the university people working with men of the industry and we are going to continue with this work but we have certainly discovered many things. As you know, the typical method of metering oil is to run it out into a gauge tank and run a stick down and gauge it. If the stick is not straight and you don't gauge it right the argument is it will average out all right, but whenever you run oil into a tank you lose some of the percentages and in some instances it will run from 3 to 8 percent and that is quite a loss of a natural resource that is as difficult to produce as oil.

On this subject of conversion of war plants, I have been told that during the first World War some 30 thousand post-war plans were developed by the Federal agencies, the State agencies, municipal agencies, Chambers

of Commerce, civic organizations and the like. Then on November 12, 1918, when the contracting agencies of the army sent out hundreds of telegrams cancelling contracts, men came back to work the next morning and found that the plants had been closed down, most of the plans broke down. They had not considered all phases of the work. I am not saying this from actual experience, I was over in France at the time, but I have been told that there were chaotic conditions and great uncertainties, things were unsettled.

Industrialists who were putting their plants into re-tooling them for the manufacture of domestic or consumer goods in general didn't know how to estimate the demands. They knew people had made money and people had money and people were spending a lot of money so their estimates for the demands in most instances were high. They re-tooled, that cost money; they staffed their plants and started to work. The first thing they found in quite a few industries the market was flooded so another lay-off resulted; around 20 percent of the personnel was laid-off. The remaining 80 percent realized that the business of working was serious, that the thing of holding a job was serious and while they had been used to receiving high wages during World War I and not working too hard, they pitched in and increased the working efficiency and the 80 percent produced as much as the original 100 percent had produced so this resulted in another lay-off. It took quite a while for things to become stabilized and groups like this must work in all directions, not only from the standpoint of research, to use our natural resources to the best advantage but in some sort of business bureau research or something of that nature, because other people have ideas, too.

After the first World War many new companies, well financed, just went broke. Well, that is not a healthy condition; we don't want that to

happen in this section of the country where we do not have large industries with reserves of manpower and money to carry through. We should act as a guiding body so far as business is concerned and certainly in our business research we can determine the demands not only in this area, but as our products become better known and our trade areas expand, the business bureau of research could give us that information.

The same things that happened after World War I could happen after this war but I hope we profit by the experience of the last war. As you know, we are really fighting two independent wars, one with Germany and Italy and the other with Japan. According to what we are led to believe World War II will end first, that is the European war, so we will ease back into the production of civilian goods in two or more stages and that should assist a great deal if we make mistakes in the first stage, we certainly should profit by them because we won't have a span of 20 years, and should be able to overcome those mistakes and reduce unemployment to a minimum in the change-over period.

Another thing, in World War I the manufacturing companies more or less picked up where they left off and used the same manufacturing methods with some improvements and manufactured the same materials, the same products. This war, as you know, has brought out numerous scientific discoveries, as a result of research, and the development of numerous new materials and we are looking forward to the use of these materials. If you read the magazines, our living will be revolutionized through television and other things that are going to be developed after the war. An old experienced concern that has been working along the lines in war industry, naturally with the experienced personnel and laboratories and research departments, can go into the manufacture of civilian goods, using the new

technique and new materials much easier than a new concern established out in this part of the country, so we will be handicapped in that respect.

The consumer is going to expect much more than we can produce from an economic standpoint, from an engineering and development standpoint, although I do not think there is anything impossible but the average consumer is going to demand more than we can produce. We will be using some products that will be inferior; it will have certain characteristics which look nice, but it won't naturally be durable, so we must be careful on what we go into. This period we will go through after the war in using new materials and new methods will be more or less a trial period, and as I said before, the companies who have had the experience can go through the trial better than the companies who have not had the experience.

Now, this proposed Mid-West Research Association can be of a great deal of assistance, not only as a pure research body but as a business bureau. In manufacturing a product you want a re-sale, it has to be a long time proposition and the person who buys must remain sold after the product is delivered and that person will act as a salesman for you and you will get your re-sale, but if the person is not satisfied, then we know re-sales will be difficult.

Anything that carries the stamp of approval of the Underwriter's Laboratory we know is safe to operate and we have confidence in that stamp of approval. I know many housewives who, when they are going to buy something, if they find it has the stamp of approval of Good Housekeeping they think it is all right. If we had, in this Mid-West Research Association, some sort of proving ground laboratory, not necessarily in

one place but scattered in various parts of the country -- I do not mean to create a monopoly, that is not the idea, but something to help the manufacturer and in turn help the consumers in the Mid-West, I think it would be a step in the right direction.

We talk in terms of decentralization. I think that is what we want to do. A lot of people when they think of converting a war plant think of using that enormous plant for some large industry. In some instances where you are close to a natural resource and can use that natural resource, I think that will be all right, if you could use the space that is available in the war plants, but in the case of one of these large aircraft assembly plants, for instance, I understand they are around three-quarters of a mile long and have considerable breadth which means there is a lot of area there. While we hope that the aircraft industry will continue to require those plants in peace time, suppose they don't. It would be impossible to imagine any sort of an industry moving into a building of that size and start producing something unless it is as large as an airplane.

When prohibition went into effect the breweries were faced with a shut-down. I know at the Schlitz plant, an enormous plant in Milwaukee, there was a great deal of talk about the high taxes they would have to pay, but instead of shutting down they didn't go out and try to fit some other large industry into their plant, but they brought in smaller industries - they had the processing steam - they had the heat - they had ventilation - they had refrigeration, so they brought in something like 400 small undustries and housed them in the plant. The Schlitz people operated that plant as a utility. As these industries which were located in the Schlitz plant outgrew their location, they either constructed a

new building or moved into existing large quarters. That same thing, a new type of utility could be developed in this area, not only by the use of war plants, but even by building larger factories than would be required by any one plant. That would have an advantage in that you could have your centralized air conditioning unit and things of that sort. Quite a few people think that you must have manufacturing plants located in the north and east because of climatic conditions. We know a man can work longer hours with less fatigue in cooler weather, but with air conditioning of the proper type, we can carry on with our manufacturing in the mid-west the same as they can in the north and east.

With all of those things it is absolutely possible to develop industries here. Let me say, Mr. Nichols, our research association can do much more than basic research. We should develop, as Mr. Nichols is trying to do, an outstanding technical library in this section of the country and we can work that in with our research association.

I certainly appreciate the privilege of coming here.

MR. NICHOLS: I think you fellows will all be interested in knowing that three of the five trustees in charge of this 6 million dollar bequest which has been left for the library were at our meeting last night, and I think they were very much impressed, and we are hopeful that it will finally be concluded that a very large part of their library can be devoted to a real research library.

Under the Will, this library would have to be located in Kansas City, and any of you who want to write me a strong letter on what you think its value would be to the educational institutions to have nearby such a library, and also your opinion on how much it would be worth to private industrial research men in this area, I would be glad to have you

write me such a letter and I will file those letters with this Board of Trustees.

Dr. Green from Kansas State is going to talk on starches.

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DR. GREENE: Mr. Nichols, you already know how much we appreciate your leadership. About 7 years ago, Dean Call, Dr. King, and I think Mr. Throckmorton surveyed our crops and decided that the best material to which to devote our research work was the sorghum grains; they have very distinct advantages. They grow at the time of year under conditions which rather effectively prevent wind erosion, the blowing of the dust, they are drought resistant, they give relatively high yields as compared with other cereals, and in addition to that they have the very fundamental advantage of producing starch in the grain cheaper than can be done in corn or wheat, and that one point I think is the major thing upon which our whole project is hinged. There has been experimental work going on at Kansas State for some 6 years; Dr. Barron in the Chemistry Department has done some excellent work on the chemical end of it and I have been fortunate enough to be working on the engineering phase of the problem. The grains have essentially the same composition as corn; that does not mean I am setting up corn as an ideal or anything of that sort but merely as a basis. It will run about 65 or 70 percent starch, so the major portion of the material is starch; the oil fat content runs 3 to 4 percent, the proteins around 15 to 16 percent and I think there has been enough discussion in the last few days on the possible materials which can be made from starch, protein and these vegetable oils that it is hardly necessary for me to take time to go into that.

Most of our work has been devoted to the processing of the grains for starch. We have done some work on the fats and oils and a little on the protein material. We have studied some fourteen different varieties which economists selected for us as representing the entire range of sorghum and in addition to that we have worked on four crosses which have been developed by Mr. Swanson at the Fort Hayes Station. One of his crosses was cleota red which perhaps is one of the best -- I would not want to go so far as to say the best, but I think it ranks very high as the source of the waxy starches which are a replacement for the tapioca and cossara starches which are no longer possible to be imported. They used to come from the Dutch East Indies, primarily Java and I might say the Netherlands East Indies, and now the research board in Washington is very much interested in this waxy cross of Mr. Swanson's with the idea of taking it back to Java. I do not think anyone thinks they can replace cossara starch, but I understand it is possible in the Island of Sumatra, in some of the drier areas to raise the sorghum and Mr. Swanson seemed to think there was some possibility there.

This cleota red has very definite coloring matter in it and we can make a light colored starch from it but it is more difficult and requires a great deal more care in processing, but this cross has the desirable milling characteristics of the white grained kaffirs and the starch has the properties of the waxy tapioca, cossara type starch.

We feel that we have the processing problems quite well solved on a small scale, and one of the most encouraging things about it is we have found as we have worked upward from batches of about 6 pounds up to 200 pounds that the quality of our starch has improved which is a very hopeful start.

We have been getting yields up as high as 58, 59 and 60 percent of starch, that is dry starch on the dry weight. The yields from corn run from 50 to 60 percent by weight so on our relatively small scale work we are getting yields of exactly the same general order as those that are obtained in processing corn.

Dr. Barron of the Chemistry Department has done some very fine work on characteristics of corn and has developed an apparatus in which I have the greatest confidence, which will distinguish between these different types of starches and that is something that has been relatively difficult to do previously, and it is quite evident from these different varieties and by the proper processing conditions, that we can make starches which will give paste of high viscosity, low viscosity or any intermediate viscosity that is desired. We know definitely if we treat it in one manner we can get a definitely higher or lower viscosity paste, as we may desire. We cannot do that in an absolute quantitative manner yet, but we are very hopeful that with a little more work and with even a little more of the factors that affect these properties that we will be able, you might say, to put the "eight ball" in the corner pocket and call our shots ahead of time.

MR. NICHOLS: You haven't brought out the fact that General Foods is quite interested in that.

DR. GREEN: That is right, they are interested in the material primarily from a food use. General Foods is interested only in that particular type of starch.

MR. NICHOLS: I have been corresponding with Clare Francis, President of General Foods. They have nineteen plants and he promised me 2 or 3 years ago that when the war was over they would consider a plant out here;

that is before they had starch in mind. I know Nebraska has been doing some very good work and General Foods have had their research men up there. Francis is pretty much concerned with the acreage that would available.

DR. GREEN: As I recall I believe the yield was about 2 million bushels in Nebraska and between 20 and 25 in Kansas, and about 8 million through Oklahoma, and down through that Panhandle district in Texas.

I have just about three points I want to make. The things I want to bring out is that the starch can be grown cheaper in sorghum than in the other grains. There is a wide variety of sorghums; we can make starches of a great number of different characteristics and general properties. It seems to me it would be highly desirable to process the sorghum, not the waxy, but just the non-waxy sorghums for starch rather than to shift to a great deal more expensive material like wheat.

DR. CALL: May I supplement just a word about the cleota club red? I think we are all in this section of the country greatly indebted to Dr. Stausled of the University of Nebraska; he really pioneered with the cleota and they ran into the difficulty of the coloring matter which was soluble in water. That led to look for other waxy endosperm types and Dr. Swanson at Hayes is particularly interested in the genetics of how the waxy and the ordinary type in-breed, and we did some work at Manhattan; the General Mills became interested, the laboratory at Peoria became interested and they found they could get a perfectly white starch from this and immediately General Foods became interested. We have sent seed to the experiment stations of Arizona and Southern California and that crop is now growing and it will be harvested either the latter part of this month or the fore part of July, and another crop will be planted this summer to be harvested in November and December, and that is being grown in

Southern California, In Arizona and in Southern Texas, and that will supply General Foods with a reasonable quantity in our area.

They have also got another variety in Texas which was produced at the Lubbock station, which, like the cleota, is not absolutely free of coloring matter, but is better than the cleota, and they are growing large quantities of that so there is going to be from those sources this year a fair supply, but from the seed that is now being grown, we will have for planting in Kansas next year an abundance of seed so I think from that time on we will be able to take care of that kind of starch.

DR. PRICE: I would like to ask a question. The question was asked last night or suggested that a specific appropriation had been made in the State of Nebraska for that type of research.

DR. CONDRA: There were special appropriations for that, but the kind of work you have been carrying on so well was suggested and an appropriation of $100,000 voted. The Governor vetoed that but we have a $30,000.00 appropriation for this work and it will be carried on.

DR. PRICE: For starch as well as other things?

DR. CONDRA: Yes, and there are many others that could be mentioned.

MR. NICHOLS: That is a very important thing to collaborate on. Let us exchange bulletins and know what we all are working on.

DR. SEATON: I think this illustrates the importance of the cooperation of research records in different fields. This illustrates an advantage of research work in organizations that are quite diversified in the character and qualifications of their men. It is a very common practice, even with the large research industries such as the General Electric Company to farm out to the colleges and universities that have these diversified staffs as part of their research work. I was talking recently with

the director of the lamp development laboratory of General Electric in Cleveland, who is one of our graduates and has the responsibility for the development of all lighting matters the fluorescent lamps and all these new developments that have been made in the last 20 years and he told me a very large part of their research work is farmed out in this way. Notwithstanding that, they have one of the best research laboratories in the United States, so I want to take this opportunity to indicate that even if the industries have these research laboratories there is much work which the colleges and universities can do to supplement and to co-operate with industrial research laboratories.

You mentioned yesterday morning, Mr. Nichols, that these industries are sending their research work to the eastern states and many of them are. On the other hand, we have had certain research projects for the last 10 or 15 years for a company in Boston so the people in the east are recognizing our ability to carry on their work while many of those in this area do not recognize it. I think there should be many more of these research fellowships and these research investigations which are being sent to the east should be sent to our own institutions in this area.

MR. NICHOLS: I certainly hope that is one thing that is going to come out of this council.

Now, let us get into the soy bean. Dr. Call will tell us about the industrial uses of soy beans.

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DR. CALL: I do not know of any subject more intriguing to talk about in connection with industrial research than soy beans. The economic value and the importance of the soy bean crop in America is proven. In

about a decade, the last 10 years we have seen this crop which was almost unknown at that time increased to where we produce on the farms of the United States over 200 million bushels last year. There is no other crop in the history of this country that has increased as the soy bean crop has increased. There are a good many reasons for that but there seems to be two outstanding reasons, one is that the central west was waiting for a crop that would take the place of oats that could be handled without equipment and the soy bean crop came in. You see, as our horses passed out, the demands for oats decreased, it was an unprofitable crop and they were looking for something else. The soy bean came intto replace the oats in the rotation of the mid-west farms.

Another factor is the increase in the industrial use of this product; it gave a market for the crop as the acreage increased and I think we must give credit for that to research; research in the industry such as the Ford Motor Company and the research in the laboratories of educational institutions, research by the United States Department of Agriculture, and I want to pause right here to give particular credit to what we call the Bankhead-Jones Regional Research Laboratories on soy beans, which was authorized by the Bankhead-Jones Act of Congress. Under this act this soy bean laboratory was established at the University of Illinois at Urbana in cooperation with all the experimental states of the United States with the exception of Arkansas. As a result of that work and the work of other researchers we have developed a market for soy bean as rapidly as the farmers have increased the production of the crop.

I want to speak now not so much about the value of soy beans as an industrial product of the whole area, but particularly the question of its value here in the Kansas City area, that is, in the states represented in

this conference. I think when we consider the use of a product for industrial purposes, other things being equal, the value of that crop is going to depend upon the cost of production and I think we can expect to see many crops utilized for industrial purposes in those territories where it can be produced the most economically.

When we consider agricultural products in this territory, in which this territory excels from the standpoint of economical production, there are a number, most of which Dr. Reid mentioned last evening. He mentioned wheat and I put wheat at the top of the list of crops when it comes to the matter of our being able, in this territory, to compete with other sections in the production of wheat. We can produce wheat in this territory probably more economically than it can be produced in any other section of the United States. I place sorghums second and Dr. Green mentioned the fact that this territory can produce sorghum economically and it has been producing sorghums in the past for the market at a less cost per pound of carbonhydrates than a corn section has been producing corn, because if you will look over the cost of 100 pounds of corn on the Kansas City market for the last 20 years and the cost of 100 pounds of grain sorghum, you will find on the average the cost of a 100 pounds of grain sorghum on the Kansas City market has been about 10 cents a hundred less than corn. I think if we begin to utilize these sorghums industrially that that differential will disappear; then it will come back to the territory where the farmer himself can produce a hundred pounds of carbohydrates most economically, and with our power equipment and with our cheap land and with the need we have for diversification in western Kansas, I think we will continue to produce starch sorghums as economically as they can be produced in any other part of this country.

I want to say just a word about alfalfa. I put this crop ahead of soy beans. In 1915 Kansas was growing a million and a half acres approximately of alfalfa - we saw that acreage decline to a third of that acreage. Why? There are a good many reasons but one reason was that with the opening of the Panama Canal they brought alfalfa around by water from California into the southern states which had been our market and we could not compete, with our freight rates on alfalfa down to those southern markets and we lost our market. Now, with the dehydration of alfalfa coming in and with our ability to produce alfalfa in this section as economically as it can be produced in any other section of the United States, I feel we have again a wonderful opportunity with alfalfa as an industrial crop.

I am talking about other crops than soy beans because I think they should be emphasized in this territory ahead of soy beans.

MR. NICHOLS: They grew a lot of soy beans down around Emporia at that crushing mill. How did their returns turn out as compared with the other crops they replaced?

DR. CALL: We do not have any record of that; as far as I know there is not any record of how well that crop has replaced, say oats or corn or whatever crop it was, but evidently reasonably well last year anyway because last year was a favorable season for soy beans but we cannot hope in Kansas to produce soy beans in competition with the best soy bean growing territory in the United States. I do not mean by that we are not going to produce soy beans. We are - we just haven't got enough crushing plants to utilize the beans and supply the needs of this state, but nevertheless I think anybody going into the industrial use of soy beans must recognize that we are not really, in Kansas at least, a real low cost producing territory for soy beans. We are going to produce them

and we are going to produce them in competition with other sections, but we are always going to be at just a little disavantage and I think we must recognize that there are going to be years when the crops will fail here when it will not fail in the heart of the corn belt because I would say, if you want to find where soy beans should be grown, look at the map of the United States for corn and in that territory where corn grows the best, is the territory where the soy beansdo the best and we are on the edge of the corn belt. In the meantime, the eastern part of Kansas and Northern Missouri is going to continue to grow soy beans and I think industries depending on that crop must recognize that certain seasons, at least, they will probably have to go back east for some of their beans for crushing, but when they have to do that it is going to be years when we need surplus animal feed out here and they didn't bring them out here and crush them and have soy bean meal, so there won't be an entire loss because they will have the freight rate on that feed out this way. I think if we don't over-do the soy bean business we can compete with the center of the corn belt.

MR. NICHOLS: Mr. Lord down at Emporia claims soy beans will stand floods very well. I am anxious to hear from the farmers. I think it would be interesting if we could get some actual experience from the farmers before we urge soy beans too much.

DR. CALL: We are getting an abundance of information from farmers about soy beans and we have had it from our experimental stations for years. Many people think that the soy bean is a new crop. Dr. Shelton, who was Professor of Agriculture at our institution for 50 years went to China and came back very enthusiastic about soy beans, and the next year he had a crop in on the college farm but we are not ready for it yet.

MAYOR GAGE: I think Dean Call is precisely right about his ranking of crops that are suitable in Kansas. I have found it that way in my farm operations. You might, however, have added Arkansas. In the rice belts you have some very good soy bean producing areas that I think are supplemental to the crop growing in Illinois. Wheat first in Kansas, sorghum next, alfalfa next.

I had an argument here within the last two or three weeks with Chester Davis on that. In order to allow increased acreage on corn they were trying to force soy beans on farms when they were not suitable for production.

MR. NICHOLS: I ask Dean Miller of the College of Agriculture of Missouri University to point out some promising agricultural developments.

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DR. MILLER: I am going to speak on something about the organization of agricultural research from the standpoint of the land grant colleges. Agricultural experiment stations were founded a long time ago; as a matter of fact, our experimental station at Columbia has been in operation 55 years, practically all these experimental stations have been established over a half century so that our history is an old one, it has been going a long time.

Originally we talked so much about production a nd improved techniques and increased returns per acre and all that sort of thing, and that is where we put most of our effort through all these years until the time came when we had surpluses of these crops and then the old slogan of trying to grow two blades of grass where one grew before came into ill repute. However, we are coming back now and we are doing everything we can to increase production.

I want to say just one word about the organization of agricultural research in connection with our states. These experiment stations are supported both by Federal and state funds; the Federal funds are allocated directly to the state under direct Federal appropriation. The money is expended and accounted for entirely in the state; however, there is an office known as the Office of Experiment Stations in Washington which has general supervision over the general expenditure of these funds and most of our projects set up in agriculture must be approved by this office. That brings a fine example with reference to co-ordinated effort and cutting down duplication. They know the work that is going on everywhere and by that means are able to coordinate the work and prevent duplication.

Then there are certain other types of research in which we work with the Department of Agriculture. One of these Dr. Call has mentioned has to do with this so-called Bankhead-Jones Laboratory. This Bankhead-Jones Act provided funds not only for the experiment stations but the Department of Agriculture for carrying out certain types of experimental projects in cooperation with the state and there are a whole group of those scattered over the United States, not only in the soy bean laboratory, but swine breeding and pasture experiments and so on. These are all laboratories set up in cooperation with the states and under direct Federal grants.

In this particular region we have an organization of the directors of the north central experiment stations of twelve states and we meet three or four times a year. We were over in Peoria about a month ago. At these meetings we talk over our problems and attempt to coordinate our

efforts so as far as the agricultural experimental stations of the country are concerned, coordination is pretty complete and duplication, while it exists, of course, is not serious, and this organization has been working very satisfactorily and continues to work satisfactorily.

I want to say a word with reference to the relation of this research to the farmer. You know the farmer moves slowly; he always knows a lot better than he does, just like the rest of us, and it takes time for him to adopt the various practices which are determined as good by the experimental stations. However, there has been a tremendous development of good practices in the last generation, particularly, and the big food program we have on now is reaping the harvest of all of these investments and investigations of the experimental stations and the farmers are making use of them. The men in industry may not understand but we have in these land grant colleges not only experiment stations, but we have extension services and it is the business of the extension services to carry this material from the experiment station to the farmer so we have a big educational program going.

As I say, farmers take up with these things somewhat slowly, but I understand in industry it takes ordinarily 10 or 15 years to get any new thing on the market. Farmers are not much slower than that and now during the War Emergency things move pretty rapidly. Our extension service is working 100 per cent or practically so on war projects; our experiment stations are working on war projects and we look at every project, its rejection or approval for the next year from the standpoint of its contribution to the war, so that is something about the way these agricultural experiment stations work.

I did want to talk, Mr. Nichols about some of the results of

research that has taken place during the year but I haven't time. You all know what hybrid corn means to this country and the improvement of cotton. You know in Missouri we have four cotton counties where the improvement in cotton varieties are now bringing in three million dollars more annually than the varieties which preceded them. We have a pasture program developed in this state, mainly through the college of agriculture which had a profound influence on this new crop we have heard so much about in Missouri, the lespedeza which has been a tremendous force in developing this pasture project. We say that the increased net income to the farmers of Missouri now, that normally was 12 million dollars, at the present time is around 25 million dollars; that is about two or three times the amount of money that the Federal Government appropriates all the states for research of any project in one state, so you can see what some of these things may mean when they are properly developed.

I want to call attention just briefly to the regional laboratory at Peoria dealing with the products from agricultural crops. We have four, as you know, of these large regional laboratories; they are commonly called million dollar laboratories; they get a million dollars a year approximately for their support. We directors are invited over to Peoria and they tell us about their work and they are making real progress. In the early days I was pretty pessimistic about the results of these large laboratories, but I have changed my mind; now they are working pretty largely on war projects but they are doing a great deal of very fine work.

Now, just a few things about the post-war. I think the war has had a very important influence on the whole agricultural situation. Every war, while it has its evils, has its benefits. The farmers in all states have learned to cooperate as they never did before. In Missouri we have

about 90 percent of the farm land in cooperation; that is tremendous when you come to think about it, getting the farmers all working together and that is going to carry over and we will have better cooperation and I think agriculture is going to be much more highly regarded; the city people are beginning to realize that agriculture is important.

We are interested, too, in maximum production. We have a committee at the university and I suppose they have them other places. All of these states are working on a plan to see just how much each state could produce under most favorable conditions of soil used to the best advantage and every opportunity taken of the things that we now know. Just how far we can go in production is a very important development. Under the AAA program in 1944, the bars are going to be thrown down and the whole thing is being set up with the idea of giving proper nutrition for the people here, for the army, the navy, and for the people we have to supply over seas. That is a very important thing I think and this wide spread development of new techniques which the farmers are now adopting is going to carry over into the post-war world. There is going to be a better development of fertilizer and there are a lot of other things that I would like to mention but my time is up.

MR. NICHOLS: I just wonder if we first check up when we start in on research on some projects to see how far Peoria, for instance, is going, to be sure they haven't already covered some of the things we are working on.

DR. MILLER: Peoria is very interested in having people work in cooperation with their experiment stations.

MR. NICHOLS: Do our university men keep in touch with them?

DR. MILLER: I must admit not all the universities do that.

DR. REID: You mentioned the time to get something into operation through the laboratories. I think most chemical companies consider a fair average 7 years from the laboratory to plant production; that is a very good average.

MR. NICHOLS: Seven years is not very long in the life of a country, anyway, it seems a little discouraging when you first think about it.

We will now have Dr. King's discussion on the potentialities of dehydration.

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DR. KING: Chairman Nichols, you know how much we appreciate your calling this conference. We have been interested in dehydration processes at Manhattan for a number of years and have, in a small way, been associated both with Mr. Small and his company and with the Cerophyl people.

When I use the term dehydration I am referring not to the old system of drying as has been done for ages in the preparation of fruit products, but to the use of artificial sources of heat that cuts the moisture content of the product down far greater than you find in just the drying process. We are now cutting down food products to a moisture content of about 5 percent.

Our interest in dehydration has been greatly intensified in the last few months by an appropriation made to the college by the Kansas Industrial Development Commission for the establishment of what they term a dehydration laboratory. That laboratory, as set up, has certain functions to perform as directed by the Commission and one of those functions is the design and construction and operation of various types of dehydra-

tors, dehydrators that may be used for home purposes or community purposes or for commercial uses, and inasmuch as the subject that Mr. Nichols assigned me has to deal with the potentialities of dehydration, I shall not take up your time by a discussion of any of the designs or operation of dehydrators, but rather confine my remarks to the future possibilities of the dehydration potentialities, generally.

Dr. Green and I just recently came back from a Government conference held at the Western Regional Laboratory in California where for 9 days we had six men appear before us lecturing on all the various phases associated with dehydration, and I came away with pretty much of the concept that until much more information has been acquired, this home dehydration business is going to be rather painful because actually when you dehydrate a product you are dealing with a very complex operation and It is very unlikely that any housewife will be able to properly dehydrate food products by the use of these cheap homemade dehydrators that run all the way in cost from thousands of dollars down to $29.50, that use maybe one burner on a gas range, but personally I am very much convinced that there will be a lot of sad experience come from these home dehydrators.

The community dehydrator is a dehydrator that will have a capacity of say 5 tons or less of products a day. That would not be considered a commercial dehydrator. A commercial dehydrator, from a governmental point of view must be a plant that has a capacity of at least 20 tons a day. There is more opportunity for a community dehydrator in my estimation than there is for a home dehydrator because a community dehydrator would be sufficiently large that at least one person could take charge of the engineering phases associated with that and they are very very essential. There is a possibility that in a community a group of women could band

together and serve as trimmers and washers and corers and otherwise assist in the work associated with the preparation and packaging of the products, but there should be at least one person there who is qualified to operate the machinery that deals with the processes which are so essential to the inactivation of the enzymes present and also run the temperature in the dehydrator. There is a possibility I think for community dehydrators.

The commercial dehydrator is one that works on a much larger scale and in which the technique of the process is in much closer control, and that requires very skilled men for the proper operation of the material.

I do not know what to say about the potentialities of commercial dehydrators dealing with vegetable products in this part of the country. When you go to countries like California where such vast amounts of vegetable material can be grown so easily, they fill very large plants. There is one plant in the process of construction in California now that has a capacity of 300 tons of carrots each day; that makes up quite a large percentage of the total amount of carrots required for the armed forces. One, I would say, should be very cautious in setting up a commercial dehydrator for vegetable products in this region and be sure that the varieties that are grown here can be dehydrated and produce proper products because variety has a tremendous effect upon the type of substance you can produce.

They have attempted in Chicago to dehydrate certain varieties of potatoes that worked very well in Idaho and were a complete failure when they tried to grow them in the soils and under the climatic conditions we have here in the Middle West, so one should be very certain whether or not the variety of the product he wishes to be hydrated is a proper one.

That brings to my mind a statement that has been made by several men here which is a very essential thing and that is that research of this type has to be tied together with a number of different departments. Our research program may involve chemical engineering, Dr. Green will direct or design the construction and operation of the machines because that is a highly technical operation; the men in the plant breeding will be in on the setting up of this program because they are the people to whom we must turn for the development of the various varieties that are required for our dehydration.

Another point that will be important will be that of reconditioning the product or bringing the dehydrated products to a moisture content that makes it fit for edible purposes. We have no formulae existing, no recipes that the ordinary housewife can use whereby she can properly utilize a dehydrated product. If you were given a can of dehydrated eggs how would you go about the utilization of those eggs? How do you reconstruct those eggs to get the qualities of the eggs if you use them as they should be used? That information is sadly lacking at the present moment and we hope to be able to furnish some of that through our home economics school.

There is an enormous lack of information in regard to what happened during the process of dehydration. After all, those changes are chemical changes; it is a transformation of matter that may be occasioned by enzimatic action. We know certain enzymes react in producing off-flavors, off-qualities; it may be due to bacterial transformation or due to moulds, but practically no information exists as to what are the causes of these deleterious changes occurring in dehydrated products, and until that research is furnished us, dehydration is never going to be the success that

it otherwise would be.

Just last week the Institute of Food Technology held a three day conference down at St. Louis and we sent three chemists from the college down to that conference and one of the dinners in the evening was given over to a dehydration dinner in which all the products that they ate, with the exception of the salad and the turkey which the Ralston Company had produced from their experimental farm, were all dehydrated products.

Our men were quite in sympathy and quite enthusiastic about dehydration, but after they had partaken of that dinner they lost a considerable amount of their interest in food dehydration. The first course was a dehydrated tomato. We cannot dehydrate tomatoes; they have to grind the tomatoes up and get what they call a puree. They made up a tomato cocktail for these poeple and two-thirds of the men there couldn't even eat it and our men said that outside of the label they had no idea at all what it was. Well, that isn't very good and that was prepared by one of our big commercial hydrators in New York City and you can well imagine that the products all came from well established concerns all the way from California to New York. The carrots they could tell they were carrots but they didn't taste so well, and the only product they ate that was really tops was a sort of pie made of apples. Those were dry apples which then had been dehydrated and it made a very palatable product. The coffee, they served dehydrated coffee, and one of our men, he is a food chemist and his tastes are rather finicky, and he said it was putrid. I must say he has a very delicate taste but he is interested in food dehydration.

I have written down here a comment made by Dr. Burton, the editor of our journal called "Food Technology". He just recently made a tour over the whole United States studying commercial dehydration projects and in

the performance here I really felt very good and felt like I might be a pretty good chemurgist. Maybe that is what we need.

MR. NICHOLS: You are on a hot line Dr. McKinley. I want to add one other very important committee, Dr. King, I want you to be Chairman with Dr. Reid, Dr. Cross and Mr. Patterson to study plans by which we can encourage fellowships and scholarships in our schools, from private industry.

(Thereupon a recess was taken for lunch)

Tuesday, June 8, 1943, 2 o'clock P. M.

MR. NICHOLS: Gentlemen, I would like to get right in to the fertilizer problem before we take up anything else. A week ago Sunday I spent about two hours with Chester Davis and I know the Government is thinking very seriously of the whole fertilizer question. Dean Curtis of Missouri University, my good friend, is here and I want him to lead the discussion.

DR. CURTIS: I dislike sounding a sour note in the chorus of enthusiasm to which I have listened for two days. I have heard many interesting facts and opinions here, and many inspiring records of achievements. I have also heard some wild schemes and some wishful thinking. I have noted an abounding faith in the magic of research.

I need scarcely remind the business men who are here that there are certain hard and cruel economic factors in the scheme of things which often operate to wreck the rosiest of dreams. I need scarcely remind those of you who have actually and personally tackled research that it is slow, painstaking, time-consuming, and soul-trying procedure. And I need not remind those of you who have

financed research that it is a gamble, and, as such, is a game which should be played only by those who can afford to lose. The stakes are high. The experience of big industry indicates that, in the long run, the gamble pays handsomely. The one research which reaches a profitable result pays far more than the cost of the nine researches which fail economically. The unfortunate part of the situation is that the small industry cannot afford the research game. It can, of course, make improvements in its equipment and in its process, but the development of a new process is usually beyond its means. It cannot afford the gamble in which the odds are so unfavorable, the stakes so high, and the long run so often a very long run.

I heartily wish that the situation were otherwise. My interest is with the small manufacturer. The big fellows are amply able to take care of themselves. I listened yesterday to an enthusiastic account of the establishment of a joint university-industry research organization. It was set up primarily to help the small manufacturer. But what happened? The contracts were nearly all with large corporations. Naturally. They were the ones who could take the gamble and, if necessary, write off the loss. Or, if the research succeeded, they were in a position to use the results. Any university can easily arrange contracts under which its technical staff is turned from the job of education to that of working for big corporations. Meanwhile the small manufacturer must remain where he always has been - far out on a limb and no net to catch him if the limb breaks.

If the technical men of a university feel the urge to help industry it would seem that they might prefer to help the manufacturers who most need help -- namely the little fellows. Perhaps they would. I

have researched for both big and small concerns at various times. The big corporations treated me very well. They always wanted to pay me more than I would accept, and couldn't understand why I wasn't interested in devoting more and more of my time to their research. The little concerns never knew that I billed them for my time at about five cents an hour, and they too couldn't understand why I limited the number of little problems undertaken for them.

Possibly it would be to the public interest for the Federal Government or the State to subsidize research for the small industries.

Agricultural research is supported by such appropriations, millions of dollars annually, and there is general agreement that this has been to the public interest. The engineering colleges and the science departments of our universities could certainly be of great help in carrying on research co-operatively with small industries, but I see no way of doing this unless and until such time as the research is supported by grants of public fund. Neither the universities nor the small industries can afford to gamble in research.

After what I have already said in regard to research, I regret that I find it necessary to say that the possibility of a large fertilizer industry in this mid-west area is not entirely bright.

Of course, the agriculture of the area needs a world of ground limestone, and the great beds of limestone for which, it seems, the distinguished geologists here present are responsible, will come in handy. The price of 10 cents a ton, which someone mentioned, is a freak price of no significance. A dollar and half a ton is more nearly the average of what the farmer pays. At any rate, there is and will continue to be a market for agricultural limestone. It should be finely ground

limestone, and the farmers should insist on getting such.

Next to limestone, the agriculture lands of the area respond most profitably to phosphate. Not much phosphate is used in the area at present. No doubt more could be used profitably and in time more will be used. The increase in use will come slowly. There are no phosphate deposits worth mentioning in the states represented at this meeting. Eventually the phosphate which the area needs, and will some day use, will come from the western deposits in Utah, Wyoming, Idaho and Montana. The raw phosphate will be processed out there and a concentrated fertilizer shipped to this area.

There is practically no potash used in this area, and my agricultural friends tell me that potash is not likely to be the limiting plant nutrient in this area for a long time to come. There are no potash mines in the area and as yet our geologists have not seen fit to correct this overnight.

The one fertilizer we do have available in abundance in this area is fixed nitrogen from the great plant at Pittsburg, Kansas. At present very little nitrogenous fertilizer is used in the area. Some day in the future there will be more used. When it is considered, however, that phosphate is needed before nitrogen, and rainfall soon becomes the limiting factor,in any event, it is hard to visualize a time in the near future when the local demands for nitrogenous fertilizer will become large enough to offer a market for the output, or even a quarter of the output of the Pittsburgh plant. All right then, let us ship the ammonia or nitrogen fertilizer to areas where there are markets, i. e. to the east and southeast. If there were no other ammonia plants in the Mississippi Valley other than the one at Pittsburg, Kansas, all would be well. But there

are today ammonia plants in Missouri, Kentucky, Alabama and Louisiana, all with the same problem of too much ammonia and too small a market. No doubt the Pittsburg plant can capture a part of the potential market, but no large fraction.

On a long range program the possibility of using a part of the ammonia capacity of the Pittsburg plant in fertilizer manufacture is somewhat more promising. There will eventually be a phosphate fertilizer plant in the west, supplying agricultural phosphate to all the states in the upper Mississippi Valley. To the extent to which nitrogen can be used profitably along with this phosphate, the nitrogen might well be added at plants near Kansas City and Omaha, a "processing in transit" proposition. Inasmuch as the ammonia plant at Pittsburg, Kansas, is a Federally owned plant, built to manufacture munitions, it may be assumed that there is no necessity of amortizing the plant in peacetime operation, and inasmuch as no private capitol has been risked in the venture there is no reason why private interests should receive more than costs plus a management fee for operation of the plant. Under those conditions, the price at which ammonia could be sold should be lower than any price heretofore known for the commodity.

There are of course many uses for ammonia other than as a fertilizer, and in time there may be developed a sufficiently large outlet to permit operation of the plant at Pittsburg. As a by-product of the war, ammonia in relatively large amounts and potentially at low cost has suddenly become available in this area. Ammonia is one of the basic commodities of the chemical industry. The problem, as I see it, is to find a means of turning the ammonia to use in chemical manufacturing. I do not see any likelihood that the plant can market much of its output as a fertilizer.

MR. NICHOLS: Who else wishes to discuss a vital subject?

DR. HECKERT: I have some figures on fertilizer consumption in 1939. In 1939 Iowa consumed 14,018 tons of fertilizer, Missouri 67,733 tons, Nebraska 2090 tons, Kansas 13,366 tons, Arkansas 74,122 tons, Oklahoma 7,622 tons, Texas 93,226 tons.

MR. SPENCER: There has been a reference to this plant we are operating and we do persist, maybe on account of our youth or enthusiasm or whatever it is, in looking on this plant as a basic chemical plant in the middlewest. It is modern, it is adjacent to the source of raw materials, it has a good water supply and cheap power and good labor, and we think with reasonable management and know-how that it can be perpetuated as a basic chemical industry. I do agree that we certainly cannot, next Thursday, divert that whole plant into a fertilizer plant because it just won't absorb it. One of the weaknesses of the plant is its size; it is a big plant and it is three times as big as we started out to build and that is a weakness but that simply makes our job that much tougher but in the long run maybe it will be that much more attractive.

In thinking of the problem today, due to the change in the war pattern, and it is no military secret now, it was in the papers last week, there is not the demand for nitric acid and ammonia nitrate that was prevalent a few weeks ago. The ammonia we are producing is still greatly in demand but the nitric acid facilities are idle today. They are modern, efficient units and with the diversion of some ammonia in those two plants on a commercial basis they can be placed in operation in 36 hours.

The diversion of ammonia to commercial utilization is not far remote or a thing that is beyond our control; I do not mean our control

but the realm of possibility. Our thought is that maybe that is a blessing in disguise; that it will give us the opportunity of diverting a relatively small portion of the ammonia from that plant immediately and to try, in a very modest way to get into these fields of fertilizer that are immediately open, and I have in mind particularly ammonia solutions which are simply an admixture of ammonia hydrate which we are making. That, of course, would have to go to the mixing plants which, unfortunately, are scarce in this section of the country.

But, thinking for a moment in terms of ammonia solutions, taking the states of Louisiana, Mississippi, Alabama, Arkansas, Kansas, Missouri, Nebraska and Oklahoma, the fertilizer figures for the past nine months which are available, those states used 1,480,000 tons of mixed fertilizer for that nine months period, the last nine months for which there is a record. That would vary some but probably little over 5 percent nitrogen. Putting that in terms of nitrogen or solutions of ammonia-nitrates, that we could purchase under this proposed plan, it would represent about 25 percent of the nitrogen that goes into those states that I just mentioned and I mention those states because after an exhaustive freight rate study, the rates from our plant to the mixing plants in those states is equal or less than from the large commercial sources of ammonia solutions in the east. So, if we can think in terms of that much optimism, that in a territory where we have an equal rate or a lesser rate than the competitor, we might be good enough to participate in 25 percent of the business. If we can carry that out as a starting point, while the Government is still demanding a large share of the ammonia for the war program, we can start the day after tomorrow because we have all the facilities and the ammonia nitrate is immediately available.

The plant is a versatile plant; it is built in units and should be broken down into units so that we would never attempt to put the whole output into fertilizer.

I leave that thought, Mr. Chairman, that this plant is complete, the investment is made, it sets on top of raw materials, it has good labor conditions and we think that it can survive.

MR. NICHOLS: I am dead sure that we need far more fertilizer in our area. Then, too, Kenneth, I am hopeful your ammonia plant will be the kick-off for chemical industries in our area.

Let us hear from Dr. LeRoy of the University of Kansas City.

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DR. LE ROY: I do not believe I have anything to add in the way of contributing something regarding the relation of resources. I might add this comment. I did not get in on all of the discussion of sunflower seed oil or soybean oil. I came in late this morning.

I remember at the University of Missouri back in 1922 and 1924 there was quite a bit of research done in the Chemistry Department and with the aid of the agricultural school on the utilization and study of the properties of sunflower seed oil as a paint vehicle. I remember the study came about as the result of some questions brought in regarding the very tremendous growth of sunflowers in southeast Missouri. I don't know whether Dean Miller remembers anything about that or not or whether he can recall whether that was ever pushed, but I know we did make quite an intensive study of the property of sunflower seed oil in regard to its drying properties and the possibilities of its use for a paint vehicle. I think it was found at that time it was not satisfactory.

Now, whether the oil can be treated and made into an unsaturated and satisfying drying oil I think is still a debatable question. I do not know how well known the use the Chinese make of the soy beans is known. If I am saying something that everybody knows just forget it. I do remember associating with a man who had been in China for some 15 or 20 years teaching at one of the interior universities and he was interested in economics and social welfare of the people in northern China and he used to tell us about how the soy beans were harvested; how the natives would grind the beans under water in something like a mortar and produce a sort of milk and then they would let that milk stand and separate the cream off of it, then churn the cream and make butter, cheese, in fact the entire economy of the people of northern China, seemed to be tied up in the soy bean industry, and I don't know how far research has gone in recent years in the United States in any of our research institutions in following through some of these uses that the Chinese have been making of soy beans for something like 1500 or 2000 years.

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MR. NICHOLS: Chancellor Mallot have you some scientific knowledge to add to this group?

CHANCELLOR MALLOT: Mr. Chairman, I attended a dinner down at Emporia for Tom Butcher, who was retiring as President of the Teacher's College, and he said it was the duty of the president of a college to get out of the road and let the people who knew something do the job.

MR. NICHOLS: Jim Price, who will be the next president of Emporia Teacher's College?

DR. PRICE: I might summarize the work we have done with the Kansas Industrial Development Commission, just to direct the attention of the group to that set-up.

As you know, our Kansas Legislature appropriated $180,000 for applied industrial research at its last session and our commission has appropriated $25,000 for a plastics research laboratory, and $25,000 for the dehydration work which Dr. King discussed this morning. These appropriations will be probably carried on next year with another like sum as the project develops.

The plastics laboratory has two definite objectives; one is to bring together the machinery in this area so that small manufacturers will have an opportunity of going into K. U. and studying and get the know-how to handle these various plastic materials so they can go out and develop certain moulding factories of their own.

The other objective, we hope to develop in that laboratory knowledge of some of thes things, namely the unique qualities of certain Kansas products such as broomcorn and more recently we have appropriated $25,000.00 in the hope that we might be able to work out a cooperative project with the Bureau of Mines in connection with the converting of natural gas into petroleum.

More recently the commission has taken under consideration the question of the starch project which Kansas State Agricultural College has been working on for some seven years and we hope to include a very all-inclusive project in bringing out the various ramifications of setting up an industry for the production of starches and sorghums.

There are two or three other projects we are interested in but they are not completely crystallized yet, such as the project involving

milling of wheat with the idea of trying to find out how to retain a greater nutritive value and how to use the gluten content of the wheat and we are also very much interested in a proposition that Dr. Heckert has mentioned, the acetate project.

In other words, those are the projects that have come through a very great screening process; we have had all the technical men meeting on these projects over a period of 2 or 3 years and have finally sifted them down to this particular group as the most important project, as we see them, for the development of industry in our area.

Likewise, we are very much interested in this whole question of developing technical maps, bringing out the resources of this whole mid-western area that will make part of the selling kit, if you please, to place before industrial leaders and we hope it will have even greater effects than this fine map that the Geological Survey showed.

MR. NICHOLS: Are you making an effort to pick out any such products as volcanic ash and bentonite and such as that that we do not hear much about but might have some potentialities?

DR. PRICE: The only thing we have is the possibility of some of those products with their unique qualities in combination with some of the plastic resins. In other words we would like to know how they might be used as filler material. There is a wide range of possibilities there.

We have studied some four or five hundred thousand dollars worth of projects, which we had to summarize down to what, as we see it, are key projects on which to spend this limited sum of $180,000.00.

I might also mention another project which we are very definitely interested in and that is a chlorination project. That has been tabled

temporarily, depending on how we work out this project with the Bureau of Mines.

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MR. NICHOLS: I think we will have the report of our committees; Dr. Buehler, Dr. Dott and Dr. Frye on the committee on the question of the composite map.

DR. BUEHLER: We have had a meeting of the committee, Dr. Dott, Dr. Frye, Dr. Condra and myself, with the four states being the area involved. Each of the states have already started and have in progress their individual maps. We feel that we can combine those maps as Mr. Nichols has suggested into a composite map of the entire area and possibly there should be included part of Iowa and part of Arkansas and Dr. Condra is going to contact the State Geologist of Iowa and I think I can contact the State Geologist of Arkansas to see if we can make this an all-inclusive area map.

There will have to be some considerable study given to the matter of the symbols on the map, possibly the scale of the map. It is all according to what you would like from the standpoint of size. In other words, we all have the base map on a one to 500 scale which would be a little larger than each state map. That means by the time you go from western Kansas to eastern Missouri you would have a map too big to be carried around and for a publicity map we feel that probably no doubt the scale will have to be greatly reduced to make it useful.

Nor, for a wall map, the present scale could be used but in that case I should say that they probably ought to be used as individual maps and when you go to put them on the wall, if they are all on the same

scale they could be combined.

All we can say is that we will produce the map. We will cooperate and produce the basic map that can be combined to make this map that you want, and in the meantime, while we are working on this matter we will have to get the scale and get the technical difficulties ironed out but each of those four states have said we will produce the basic map.

MR. NICHOLS: And as far as you can you will maintain common symbols?

DR. BUEHLER: It may be we cannot do that exactly but there will be a legend that will give you all the symbols that are needed.

MR. NICHOLS: If it is agreeable with everyone we will let that committee still stand and let Dr. Buehler be the chairman of it and keep pushing along. I think it is a very important conclusion that your committee has reached.

DR. BUEHLER: I will keep in touch with you with regard to it and see what progress we can make.

MR. NICHOLS: Thank you very much, Dr. King, you had the committee on encouragement of fellowships in our institutions.

DR. KING: This committee, composed of Messrs. Reid, Patterson, Cross and myself thought that we should not have a meeting of this type without some resolution and so we have written our comments in the form of a resolution, realizing full well that great good can come to this region, both industry and educational institutions from such conferences and further realizing that a conference of this type has no administrational duties in forcing universities to take up certain types of work.

"Be it resolved that it is the sense of this conference first, that a close spirit of cooperation should be developed between industry and educational institutions, looking through science and engineering to a greater mechanical development in the middle west; second, that the industries of this area make known to the educational institutions their research needs and their educational institutions furnish industry with an outline of their facilities, both as to personnel and physical equipment and indicate the fields of research in which they are best qualified."

I move that this resolution be adopted.

(Upon a second from the group the resolution was adopted).

MR. SPENCER: Dr. King, with reference to that resolution, I might just add that in 1939 the chief engineer of our company went up to Manhattan to discuss with the college there the possibilities of some fuel studies leading toward the utilization of collodial fuel, a mixture of coal and oil and that research was undertaken there, carried along as sort of a secondary study for some time and then here some 8 or 10 months ago when the fuel situation became more critical that situation was intensified and additional talent there at the college was put on it and we worked with the college and all of that has resulted in a very tangible set of answers in the production of a collodial fuel which is about 40 percent of coal or solid fuel and 60 percent by weight of oil.

During a time when oil restirctions were prevalent there was a great mass of research work done there for stabilizers to keep solids in suspension and they even went to the extent of the development of new machinery to properly mix solids and fluids together, all resulting in a very practical answer and we have now mixed those fuels in carload lots

and incidentally it has now been, for the past three weeks on a burning test out at Montgomery-Wards, at a very efficient power plant where they have cooperated the whole way to carry on the experiment and incidentally if anybody would be interested in seeing it burn I would be glad to have them drive out there and we can arrange for admission for you to see that demonstration.

I just point that out as an example of this sort of cooperation of industry with the fine institutions and the fine cooperation of that college with an industry here in town.

MR. NICHOLS: I feel your committee, Dr. King is working on a most important matter. We have a committee for the study of the possible allocations on research in common products with a pooling of results between our institutions in order to keep our institutions working together and avoid waste and duplication. Dr. Branson is chairman.

DR. BRANSON: Mr. Chairman, the committee made a formal report as follows:

First, that the chairman of this conference, Dean Nichols, appoint a more permanent committee to consist of one member from each state concerned, and an over-all chairman; second that the member from each state assemble data on research organization and companies in his state, together with lists of research projects under way and projects in which they desire to help or wish to collaborate with other organizations; third, that the over-all chairman assemble all of the reports and call a meeting of the committee for discussion of further procedure. Signed by the committee, O. J. Ferguson, Ray Q. Brewster, E. B. Branson.

I move the adoption of that resolution as the sense of this meeting.

(Upon a second from the audience the resolution was adopted.)

MR. NICHOLS: An excellent move Dr. Branson. We have one other committee to hear from of which Deane Mallot is chairman.

DR. MALLOT: This committee was a large committee composed of academic people and it would have delighted the author of that quip who said "A professor is a man who thinks otherwise".

We had all sorts of thoughts and gradually a certain pattern emerged and we felt a unanimous sentiment that this meeting was extremely worth while and that future meetings would likewise be worth while, but that if we were to have future meetings, we would need some sort of a permanent organization for this group.

It was clear also in the time at our disposal we could not bring to you any suggestion for a formal permanent organization because there, again, there were a great many different ideas. We felt that we might rally well around Mr. J. C. Nichols because of the wonderful job he has done in getting us together, in giving us this valuable meeting and somehow or other with his usual reticence he has brow-beaten a number of his friends in Kansas City into financing it with him out of their respective pockets and that is an ability that we do not want to lose for the future.

So, therefore, I have the following report of this committee to consider further meetings and organizations:

"It is the sense of this committee that we establish a permanent organization looking toward future meetings and we further recommend that a permanent research organization be perfected under the chairmanship of J. C. Nichols, who is hereby requested to call together at his convenience an organizational committee with representatives from the universities and colleges and from industry for the above stated purpose.

Mr. Chairman, as the chairman of this committee and on behalf of the members I move the adoption of this report.

(Upon a second from the audience the report was adopted.)

MR. NICHOLS: It is gratifying to feel that you think this first meeting has been worth while enough that it has justified some kind of a continuance. The thing I question is putting my name in as chairman, but I will be willing to do it with the understanding that when the permanent organization is set up then they can select their own chairman.

Is there anything that we should adopt here or any other thought that should be put in the form of a motion not covered by any of these committees coming out of this meeting? Have we overlooked anything that there might be some action to take on by this group?

Let anyone feel perfectly free to discuss any thoughts they have of that kind.

Mr. Turner, you have been sitting here quietly. Mr. Turner, as you know, is the technical assistant to George Oberfell of the Phillips Petroleum Company, who gave us that fine talk last night.

MR. TURNER: Mr. Chairman, I do not have anything to add of any constructive value to this group. I endorse it fully and look forward to seeing it grow and will watch it with a great deal of interest and I am sure that expresses the opinion of Mr. Oberfell as well as Dr. Wagner.

MR. NICHOLS: I wish to convey to Mr. Phillips and Mr. Adams our appreciation for your coming up here and joining us in this meeting.

Joe Stephens, have you anything to add?

MR. STEPHENS: Nothing other than to say that I think you

had a most marvelous meeting and I personally have been happy to have been associated with such a fine group for this brief period. I think you have started something splendid and I hope it will carry on with its present fervor.

MR. NICHOLS: Roy Cross, have you anything to say?

DR. CROSS: I haven't anything to add, particularly. I will say this, however, that there is one resource you have not talked about very much here that I think is one of the best resources in this territory, that is Mr. J. C. Nichols.

There is one project that I wanted the Wichita University to work out and that is the pipe line for wheat to the Gulf Coast.

MR. NICHOLS: Men, you have made this a great meeting. I am pleased you do not feel I was presumptuous in calling you here. I believe we are creating a stronger and closer tie for you with private industry which is so important to the preservation of America.

I hope this meeting will bring all our school research men closer together in their work and also make you realize more than ever before, your important research leadership for the middle west. Le us challenge any idea of any static farm maturity.

Let us not despise any small beginning in research -- a tiny spark may burst into a mighty flame.

Let us build greater nearby consuming markets for more farm products. Let us balance agriculture with industry. Let us promote our small towns.

We will not sit idly and see our population dwindle.

Let us study, toil and demand a reasonable parity with other parts of the nation.

As I think back for our two days' discussion, I am sure you have the daring; the vision and ability to carry on and I am glad to pledge to you the continued interest and service of myself and all the Kansas Citians who have helped make this conference such a grand beginning, and I predict a far greater ultimate success in our next conference.

Again - Goodbye - thanks -- we shall be meeting again soon in this great cause.

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Note: After the meeting the following partial list of the minerals of this area was compiled, and included in the report of this meeting. (Some in very small quantities).

Alabaster
Antimony
Asphalts liquid
Asphaltic sandstone
Bauxite
Barytes
Casinhead gas
Cement
Coal
Clays
Colonite
Copper
Cobalt
Dadmium
Dolomites
Diamonds
Feldspar from pegatitic granite
Fullers Earth
Granites
Grahamite
Bentonite
Gypsum
Glass Sand
Heliumgas
Ilmenite
Iron
Impsonite brines
Lead
Lignite
Limestones
Manganese
Marble
Mercury
Metabentonite
Nickel
Natural gasoline
Novaculite
Natural Gas
Sand and Gravel - ordinary
Ocher
Petroleum
Pigment Materials
Phosphate Rock
Porphyry
Pyrite
Quartz Crystals
Rockwood rock
Rock asphalt
Silver, produced as a by-product of regaining lead
Salt
Shales
Slate
Sandstone
Strontium minerals
Syenite
Tungsten
Tripoli
Titanium
Umber
Volcanic Ash
Zinc ore
Ziecon