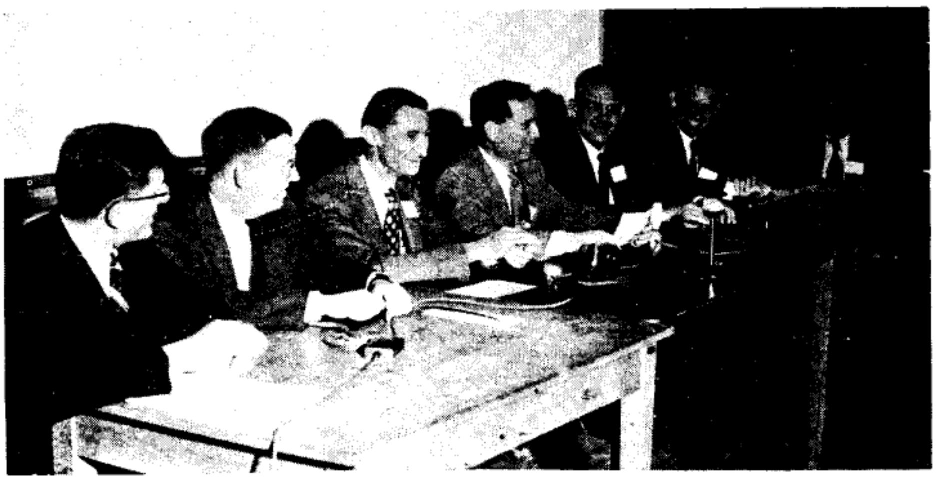
Panel Discussion On Electric Power vs. Gas Engines As The Source Of Power For Pumping Wells

Each member of the panel will be allowed ten minutes to express his opinions. The next forty minutes will be devoted to the members of the panel questioning each other and we will set a five minute time limit on each question and answer. The remainder of the time will be devoted to questions from the floor. The persons at the speakers' table are Mr. Gus Athanus with Stanolind Oil & Gas; Mr. Poore with General Electric; Mr. Woerner with Texas Electric Service; I am Neal McCaskill with Atlantic Refining Company; this is Mr. Platt with Ajax Iron Works; Mr. Gatewood with Waukesha Sales & Service; and Mr. Slonneger with Continental Supply Company, Dallas.

Mr. Woerner of Texas Electric Service Company

I should like to preface my few small remarks here with a tribute to the engine people. We have no quarrel to pick with them. We thinks that engines are good; they must be good or they would not have been used for as many years as they have. We find that the competition that we get



The Discussion Panel

NEAL McCASKILL, Moderator
Atlantic Refining Company

GUS ANTHANUS
Stanolind Oil N Gas Co.

J. N. POORE
General Electric Co.

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Ajax Iron Works

FRED WOERNER
Texas Electric Service Co.

T. B. GATEWOOD
Waukesha Sales N Service, Inc.

J. C. SLONNEGER
Continental Supply Company

from the engine people is almost always fair, and it's clean and it's good for us, and we appreciate their cooperation and their competition. Engines do a good job; they are semiportable; they do require maintenance, of course. They do require overhauls, of course. They can use lease gas sometimes if it is sweet and if there is no outlet for the sale of that gas. However, we find that with the increasing cost of labor and with the increasing value of gas, and perhaps with the increasing amount of utility lines running through the oil fields, that more and more producers have begun to use electric motors for the oil well pumping.

I do not intend to attempt to talk about motors because we have Mr. Poore, who is an expert on that subject. Nor do I feel that it is in my province to talk about usage of those motors, because Mr. Athanus is certainly more familiar with that than I am. And so I will confine my remarks only to that link in the chain which is the utility portion of the story—The electric utility industry—and I will speak, if I may, for the entire industry rather than for my own company. We do provide electricity. We want to provide a service of which a part is the actual transmission and delivery of power. We are in the oil business fully as much as any of the oil companies here represented, although we do not have any wells and we do not have any production. Our future is tied up with yours. And if you are operating and making money, then we are operating and making money. And so we are very much concerned with your well being. And we realize that we must be responsible for service continuity, for that electricity being there when your motors are required to run. We must be responsible for constant voltage and for constant frequency. And we must make a duty of ours the formulation of rates which will allow me to get paid and will be equitable and reasonable and competitive. And we expect these things. And we keep them in mind at all times. And we also realize that just as no engine installation is any better than the fuel supply which feeds the engine and that in freeze-ups and failures of controls and a few things of that sort will cause the engine to cease to operate as though the engine itself had a malfunction. Just in that same line of reasoning, so no motor installation is any better than the utility line that feeds it. And to that end we have gone to a considerable lot of trouble to build lines which are built and prepared and ready for heavy loading in order that they might withstand ice and wind storm. We have built substations and insulated our lines in order that we might control the lightning which does occur here occasionally when it rains.

We have built up a pool of trained personnel and provided them with trouble-trucks and with line trucks and equipped those trucks with radios in order that our people may be available to keep our service operating 24 hours a day, and 365 days a year. In doing this, we have received a good deal of advice and constructive criticism and actual help from the oil industry as well as from manufacturers of equipment. And we deeply appreciate the confidence and cooperation which these people have shown and in return we have sincerely tried to be honest and fair with our customers. We have tried to make no promises which we do not intend to keep, nor make any statements which we do not believe.

We have tried, and we will continue to try, to stay abreast of the latest concepts in power production and power transmission in order that users of our electricity will be able to concentrate on their primary job, the production of petroleum and petroleum products, leaving the power production to us. We have, for example, like the cooperation I mentioned a moment ago, we have managed to install many more sub-stations, that is many more points where we step down from a transmission to a distribution voltage in the oil fields in order that each of these sub-stations might cover a smaller area and might make our service more dependable and more efficient. And we offer to you as our users and our customers an opportunity to use automation — automatic equipment, if you please. We offer you a savings in labor. A savings certainly in maintenance. We offer you freedom from worry about production of power. And we offer you our fullest cooperation in solving any of your electrical problems. We appreciate your help and your business and we hope that you will let us continue to serve you and be of assistance. Thank you.

Mr. H. L. Platt of Ajax Iron Works of Tulsa, Oklahoma

We, as gas engine people, also believe that electric power has a place in the picture. We believe that, by and large, the gas engine fits most of the oil company applications better. Definitely where the power requirement is small, 5 to 7 1/2 horsepower, the electric motor has some things to recommend it. At least it is debatable if this type power should be used at that point. If the operation must be cyclic over a 24 hour period, then the electric motor too has a very real place in the picture. But in the final analysis, the prime mover on an oil well pumping unit should be chosen from a straight economic standpoint. When gas is purchasable, if it is available, from a power standpoint, very seldom if ever, can we justify, other than a properly designed, and applied gas engine to the prime mover. Certainly electricity at 1c a kilowatt, and gas at 25c a thousand or less, the gas engine is the cheaper of the two types in their proper application.

Now, when the decision is made to electrify, on what grounds, or what are the factors that usually prevail to make the electric motor the prime mover. I have found that usually the decisions are based on two factors. 1. The lower initial cost. We've no quarrel with the statement that electric motors are cheaper initially than the equivalent horsepower in a gas engine. However, if we do figure the total cost of the installation, not only the motor, but the transmission lines and all the auxiliaries required to make the proper installation, that difference in initial cost becomes much less than is usually considered. The final decision is one that Mr. Woerner made—that of labor saving. You know in this day and age I doubt any word in the technical vocabulary is more overworked than this word automation. It seems to me that all we mean by automation is continued mechanization. Actually the gas engine can be equipped with devices that will give periods of operation unattended for—oh, we measure them in months now. So the amount of attention that the gas engine requires is a small portion of the total attention that the pumping installation requires.

I firmly believe that the frequency with which the well is visited is not predicated on the prime mover—be it an electric motor or a gas engine. In some instances—I had a very real demonstration of that very recently—the labor bill at the field level is reduced slightly by so called automation. Actually the amount of supervision and technical help that was required on top greatly increased the total cost. More often oil pumping operation is a mechanical job. We require people with mechanical aptitude to accomplish the task. The gas engine is also a mechanical device. We require less specialized attention so that the overall cost very truly is less from a labor standpoint. Another thing that has been brought forcibly into focus recently, we have a very real shortage of technically trained men. We should be training a great many more men with mechanical aptitudes for some of the supervisory positions in the producing industry.

This mechanization of the pumping installations has become more refined and we do, therefore, have a better opportunity to train men with these latent supervisory capacities to develop a very real pool of man power which should properly then free many of our engineers for truly engineering jobs. In the final analysis then, much of this so-called automation is a misnomer. Anything that we want to do automatically with one type prime mover, we can also do with the other type of prime mover. And certainly the gas engine requires a great deal less specialized attention, highly trained, technical help. Each installation becomes an entity unto itself and not dependent upon the technical assistance of a power source miles away. Generally, the fuel — the life blood of the power is available at the casing head—a joint of pipe away.

In conclusion, I feel that all of us have been quite influenced by all the electric gadgets around us—its the modern way of doing things—and we have sort of passed up some of the progress, some of the advantages that can be easily brought into the picture from the special type of equipment that is designed specifically for the job of pumping oil wells. I thank you.

Mr. Poore of General Electric Company, Dallas

As a little bit of a backdrop on my remarks, I would like to tell you about a survey that my particular company has made over the past several months which was an eye opener even to most of us in my company and I am sure that it might be to some of you. We have often wondered and when we discussed it with publication people, with the oil industry, the power companies and with our competitors how much of this—the oil fields—are electrified, there has been no answer other than kinda plucking it out of the sky and pick a figure. So in the interest primarily of our own sales department we made a survey of over 5,000 people in the oil trade. They consisted of the field superintendents, the engineers, the purchasing agents, and anyone in the oil industry that would have a factor or play a factor in deciding one way or the other whether to use engines or motors. And we asked them several questions: No. 1 was—"Aproximately how many of your wells on your particular lease, or area, or division, or what have you, are on electric pump today, or as of 1955." And then we asked them to prognosticate with us to help us do some of our planning as to how many they anticipated they would have on electric pump by 1960. Then to go a little further, we asked them also to tell us something of the breakdown horsepower wise of their electric pumping. And the results were quite amazing. You might like to know about it.

The survey was made primarily for Texas and Oklahoma, and of the total oil wells in both states, not just the wells on the pump or artificial lift, but of the total oil wells, 38 percent are now electrified. This figure comes from you people in the oil industry, they are not our figures. Of this 38 percent, 40 percent of all the oil wells in Texas are on electric power, and 32 percent in Oklahoma. In 1960, again the oil industry themselves told us that they anticipate that 52 percent of the wells in Texas and 45 percent of the wells in Oklahoma will be on electric drive. Then to break down how these motors will break down horsepower wise, we asked them, primarily because our motor department happens to be broken up into two departments at the 7 1/2 horsepower level. So we asked the oil company how many of their wells had less than 7 1/2 horsepower motors on them and how many had greater. And of all the wells electrified only 17 percent were less than 7 1/2 horsepower, 83 percent of all the wells electrified were 7 1/2 horsepower or greater. Why is this electric power usage growing. I can remember when I first got into it that if we had 20 percent of the wells electrified, we thought that was amazing. And the growth has continued over that period up to the present time and it's anticipated that this growth will continue.

I don't quite agree with Mr. Platt's comment about automation because I think it's the coming—if it's not already here—at least the coming thing in all industry, not just the oil industry alone. The key to any reduction in cost, and efficiency in operation, is in trying to do that automatically. Certainly electric motors and electric power lend themselves most admirably to automatic operation. An automatic time clock on a well or on electric motor pumped well can certainly pump that well at its most efficient rate, contingent upon the well conditions for the specific well. When you select a prime mover, whether it be a gas engine or be an electric motor, there are more factors than just the cost of fuel to be considered. Too often, only the first cost of the equipment and the cost of fuel are the only two factors taken into consideration. Anyone that makes a decision, one way or the other, on only those two points is not playing very fair with himself nor with his company's money. Other factors that have to be considered, besides first cost and fuel, are will that gas supply always be available. Sure you have gas at the casing head today and it may be there for several years, probably there longer than the life of the engine, but certainly not longer than the life of a motor. Its particularly true in water flood operations where almost invariably the operator goes to electric drive on his producing wells as well as the rest of his equipment on a water flood installation. The gas engine itself is built primarily to have its maximum efficiency under constant speed and load conditions.

Now you all know that well load can vary considerably and particularly so on a water flood installation where your horsepower requirement is very low to begin with and gradually builds up over a period of time as the water encroaches into your oil. The engines cannot be operated at their optimum efficiency all the time under a varying load condition like that. Motors on the other hand have a relatively flat efficient curve from half to full load. So that in most all instances the motors can be operated pretty close to their optimum efficiency point. Automatic controls eliminate the human element to a great extent in your operations and it allows you to make better use of the personnel you have on your lease for the primary function of your Company's operation and that is to produce oil, not to make electric power or to maintain engines. Maintenance due to sour gas in the West Texas area is well known to all of you who have used engines. There are other factors besides sour gas—you have a relatively high mineral content in your water, you have occasionally freezing weather to contend with out here, you certainly have dust storms to contend with out here.

About three or four years ago, one of the major companies operating in the West Texas area made a study for their own company use on the cost of labor and materials for maintaining and operating engines vs. motors—electric motors. The results of that test indicated that for multi-cylinder engines, that cost approximated $22.00 per month. For single cylinder engines, it approximated $14.00 per month, and for electric motors it approximated $3.00 a month. Now, I fully agree that maintenance cost can vary from one area to another. The East Texas area, which happens to be more in the sweet gas area, operates I am sure at less cost for gas engine maintenance. Another major company in East Texas did about the same thing as this one in West Texas did in trying to arrive at representative maintenance cost figure for their engines. They found as a result of their survey of quite a few engine installations of theirs that the cost of maintaining the single cylinder engine was approximately 2c an hour, the cost of maintaining a multi-cylinder engine was 3c an hour. I see they also had a two-cylinder engine in there at 4c an hour.

I will just wrap this up by one comment. I believe that if you can believe the increasing trend in electrification that this survey of ours reports, certainly then it is representative of the fact that the cost of electrically pumping wells is less than to do it with engines, otherwise you people in the oil industry wouldn't do it that way.

Mr. Gatewood of Waukesha Sales and Service

There is one phase not to be overlooked in reviewing the case or the cause of the gas engine—that is the flexibility. Now, I'll take exception to Mr. Poore's remark that the gas engine isn't adaptable to a change in the constant speed. In other words, he feels that the speed and load have to remain constant. We don't believe that is the case. We feel that a gas engine is much more readily adaptable to a change in load or a change in speed than is your electric motor. True, in some cases, it might be necessary to change the sheave to change the ratio and get more horsepower at a given speed. Also, we might want to lower that speed and, to keep the efficiency of the engine up, we would increase the size of the sheave and maintain the horsepower requirements that we want. On the other hand, if a large enough motor to take care of his peak loads is used, and at times it might be operating 50 percent loaded, he has a higher demand charge than otherwise need be the case. It's possible to operate your pumping unit, control the number of strokes per minute, by governing the engine.

Again, we say, that is something that adds flexibility that you wouldn't have with the electric motor. In your cyclic pumping, your off and on arrangement with the electric motor does have advantages in the electric clock. However, there are occasions when it might be advantageous to slow the unit down. Once again we can do that. As I mentioned before on a well that is expected to require say 50 horsepower at a later date, but at the time it is put on the pump, it wouldn't require that much horsepower. It is easy to go ahead with the industrial engine, put the larger engine on, as I mentioned before, sheave it back, or take a ratio where you can pump efficiently and then at a later date, when you increase your requirements you can speed up the engine, reduce the size of the sheave and continue to operate, whereas the demand charges on the electric motor would again enter in. It would seem that—speaking of efficiency—you take a generator plant—you lose some efficiiency of course in generating the electricity. You lose some more in transmission of the electric power to the pump site and again you lose some at the site.

The electric motor of course is highly efficient, but it is operating on what we would call a refined unit—the electricity. However, at one time that was produced from the raw gas or the residue gas. We can do the same thing with the engine at the site. It isn't necessary for us to go back to more than a scrubber perhaps, or something to clean the fuel up. We can use fuel that would otherwise possibly be burned, wasted. At the best, the cost of it is extremely small. However, Mr. Poore, may be there is merit to the small electric motor. When you get above—say 25—that is rather broad, I think 15 at least should be the breaking point, it begins to become more and more apparent to economics involved in the gas engine. I have record of at least 10 wells by one company using a 75 horsepower electric motor, the electric bill ran in excess of $1,000.00 a month. It is inconceivable to me that a gas engine, even though we might have to overhaul it—I would say every six months—which we would all feel rather badly if we had to do that—not only the engine people but the oil compaines. But it would be pretty easy to maintain an engine and maintain an operator and still show a money in the bank so to speak.

While it works a little bit different on the smaller end probably due to maintenance among other things. Certainly I don't believe that electricity can be justified on the larger usage. Agaiin, this is a small point but we do feel there is a safety factor involved in your electric motor. We attempt to use foot guards on belts, sheaves, and that sort of thing around the gas engine. However, a short or slight shock might not be injurious due to the shock involved, but it could cause the operator to jump into other pulleys and causing some trouble in that way. Again as the operations get more wide flung, there is transmission lines and your electrical power to be considered. In addition to what might be classified as acts of God, lightning, tornadoes, wind, ice and that sort of thing even a truck can hook a line. A truck can knock a pole down and cut off service. In general, your fuel line to the gas engine is buried underground—in most cases it is quite short.

Again we might point out that many wells are dependent upon the electric supply through the transmission lines, where as in the case of gas engines, if you should happen to disrupt the supply of fuel to an engine, one engine would possibly be involved. Therefore, you wouldn't have as many engines shut down at that time. The equipment that is available now—what we call the long run equipment—has also helped the engine manufacturer to reduce the maintenance cost. I think this will more and more prove the case that the equipment is now out of the experimental stage and I think it will become more apparent as time goes on. The human element is also eliminated in some measure there, speaking of automation, but I feel that anything that can be done to reduce the service necessary to that engine, is beneficial to it. And it's no extreme case now to find units that run as much as six months or a year without service from the oil companies.

Mr. Athanus, Stanolind Oil & Gas Company, Lubbock

I don't represent any of these engine manufacturers or any of the electrical companies or electric utility companies and I was asked to give you our experience, particularly in this area, as to electrified vs. gas engine pumping. I have no title to my paper except the advantages of electrified pumping. We have virtually all of our wells in this district electrified. I don't know what the percent is, it is above 95, so there must be some advantage to us and I must say in prefacing my remarks here that this is—there are certainly some features about this area—in this country out here that must be taken into consideration in arriv-at an economic analysis of the two methods of pumping. Virtually all of our pumping wells in this area are in fields where the casing head gas is sold to a gasoline plant, also it is used in repressuring operations. This gas that is commonly used for fuel for gas engines, we assign a very tangible value, the value of which has been increasing over the years and I dare say it will continue to increase even if the F.P.C. continues to regulate.

The wells in most instances are located in concentrated groups, of course, this favors construction of electrical distribution systems. They are not isolated wells. We have an immediate supply of high voltage electricity available to us in virtually all of our operations. Another factor is the casing head gas in the fields in which we have electrified and most of which we operate is sour and the maintenance cost of engine operation is increased because of sour gas. One final factor is cyclic operations. We are under a high degree of proration. We also try to fit our producing operations to meet the gasoline plant scheduling so we find the automatic operation afforded by electrical pumping to fit into that category very nicely. In electrifying our wells, we have a long experience to draw from and we have conducted some economic analysis of operations in this area. True, they may be several years old now, but we have found that in one particular study where we are talking about 4,500 to 6,000 foot wells, the cost to pump the well and operate it with a gas engine was 5.6c per barrel where it was 4 1/2c under electrified operations. Now these operating costs for the gas engine include maintenance and repair expense, fuel costs, lubrication oil expense, pumping labor, engine replacement, and losses in production due to down-time.

For electrical operations, the costs include power cost, maintenance and repairs to the motors and controls, maintenance and up-keep to the transmission system, pumping labor, and again production losses due to down-time. In considering operating expenses in this area, we assign a life of a gas engine in these studies of about 8 to 10 years due to the sour crude service and overhauls of more than minor nature, approximately every two or three years. Electrical motor life, we assign an arbitrary value of 25 years. Now we have motors in operation for longer periods than that. Investment costs on both types are virtually equal in this area. The cost in a gas engine operation—the cost of the engine to pump a well of 4,500 to 6,000 feet in depth is around $1,000 to $1,600. Now this doesn't include the associated expenses to install the engine.

For example, if the engine is fueled by casing head gas from the well head, a fuel gas scrubber, a gas regulator and certain piping and valving are required. If the gas is fuel from residue gas, then you have the line to bring to the well and certain valving and regulation there. For electrical installations, the cost of a motor for 10 to 15 horsepower, including the controller, is around $400 to $500. And the expense of course of a transmission system chargeable to that well will vary from well to well depending upon the amount of primary and secondary wiring required. But it varies anywhere from $900 to $1,500. For example, about four years ago we electrified a project of 56 wells and I just jotted some numbers down. It cost us $1,600 per well in complete investment cost. Neither of these estimates that I have just given you include cost of foundation, belting, sheaving, and so forth, because I figured that they would counteract each other on each type of installation. We have found that our pumpers can operate more wells under electrified operations than they can under gas engine operation. In some instances from 50 percent more to sometimes 100 percent more. It will depend on the number of wells on the lease connected to the tank battery which you are producing into. As many of you know, most of your pumpers time is spent at the tank battery and when you can cut that down the pumper is allowed freedom to move around and operate more wells.

There are experience factors in planning pumping jobs. There are certain intangible advantages which we also include. First of all, there is control of production. Many of our wells out here are prorated and we also have many low volume producers. In such wells where engines are operated—fueled with casing head gas—sometimes we have been confronted with an operating problem where there is insufficient gas to operate the engine. To supply gas in sufficient quantity we often times have to pump wells continuously even in a pumped-off condition. And sometimes we have had to augment our gas supply with some type of LPG. Not only are the direct lifting costs reduced when the pumping time is reduced to a minimum commensurate with the capacity of the well to produce or the degree of proration, but savings on wear and tear on the associated equipment, such as pumps, rods, pumping units and etc., are greater when the well is not pumped continuously.

We have conducted on most all of our electrified operations studies of the period of time—the optimum cycle—to pump these low volume producers and we have a great number of them. We can't afford to pump those well 24 hours a day, in some instances not even every day. So we find that the ease of control was a very decided factor and tangible benefit. I would like to say one thing about automation. We have one project here and we are about to put in another one and we have it all on electricity. We find that our investment costs in electrical operations of pumping operations are helping us now in our automatic operations.

Mr. Slonneger of Continental Supply Company

I am somewhat pleased and surprised that Mr. Poore should have suddenly jumped over and taken the side of the gas engine. I didn't expect that. He pointed out that it cost about 3c per hour for such things as oil and what not to maintain a gas engine and since there are 720 hours in a month, at 3c an hour that would be about $22.00. Now the cost of such material for the electric motor, of course, isn't very much. But the material known as kilowatts cost about 1c an hour per horsepower delivered at the polish rod. So that for a 10 horsepower motor, delivering 10 horsepower at the polish rod, it would cost you 10c an hour for the material—kilowatts—for that particular motor. And in 720 hours that would be $72.00 a month, which is a $50.00 clear profit for the gas engine. We have found that even when we have to purchase the natural gas to operate the gas engine in the neighborhood of 10 horsepower delivered at the polish rod, we can afford to pay as much as 40c per thousand cubic feet for the gas and still come out ahead of purchased power at 1c per kilowatt per hour. But most of the time our fuel costs for the engine is practically nothing—it may be had for the taking. So if we start to figure on the basis of the 10 horsepower delivered at the polish rod which might require a 15 horsepower motor, we see that we have a clear case of the gas engine on practically all counts.

Mr. Poore pointed out also that fully 17 percent of the motors in a given area were less than 7 1/2 horsepower. I would be willing to wager, two to one, that of the 15 horsepower and 25 horsepower motors he had in that same territory about 50 percent of them were not putting out more than 4 or 5 horsepower. I get lots of dynamometer cards in which we have motors of 25 horsepower or even 40 horsepower putting out 6 percent. And there is where the delusion comes. The man thinks that he has got a 40 horsepower motor and he is operating it for rather small cost. He thinks that he is putting out 40 horsepower. He is not doing anything of the kind. He is putting out 7 or 8 maybe. And he thinks that he is operating a 40 horsepower motor for a very, very small sum. That is not the case at all. He is paying pretty high for the small amount of power that he is actually delivering.

There is another aspect of this whole problem that should be given due consideration by the men who finally make the decision to go to electrical pumping. The wells of most oil fields especially where there is water encroachment, start out by using a very small amount of power to get the production, and as the field gets older and older, more and more water comes and it costs just as much and maybe a little more to lift the barrel of water as it does to lift the barrel of oil with the results that the returns from the field—that of the oil—becomes less and less as the cost of lifting that oil together with the water gets more and more. And finally we run into the situation where the cost of producing that oil is equal to the value of the oil itself and at that point it becomes necessary to abandon the field. Now if we have our cost of lifting lower, we can very well continue to produce that field perhaps another two more years before the cost of lifting equals the return from the oil.

In other words, if we have cheap power, and cheap power is the gas engine, especially when you have to have a large amount of power, say 7 1/2 horsepower or more, the gas engine is the cheapest power that you can buy and with the cheapest power you can produce the field just that much longer. Another situation develops that as the power required get's more and more we suddenly come to realize that we are to the limit of the transmitting lines that feed the lease. I have in mind a certain case where it now becomes necessary for the power company to add more transformers and more primary lines from the source of power to the lease. But because the lease is pretty well depleted, they don't know how many years that will run, how long will that rapidly vanishing field continue to buy power? Will it continue to buy power long enough to pay for the installation of the new lines. Maybe, maybe not. Who knows. The field may peter out in three or four years. It may be that they might have to abandon that field long before it is really depleted, unless they can go to such a thing as water flooding. But all pools finally peter out. And when they come to an end, what about the salvage of the equipment that you have got on them. You could cut your poles down and pile them up and burn them, They are not worthwhile to try to salvage, either the poles or the lines.

In the case of the gas engine, you have almost a 100 percent salvage value, so to speak. We find gas engines that use to be in West Texas, we have brought the same gas engines up in Kansas and that isn't all. They get the gas engine and haul it up there and sit it down and wind'er up and they are ready to go. You can't do that with electric motors. You first have to have some lines built before you can move that electric motor. It doesn't get its energy out of the air. The gas engine—you just hook it up to the casing trap and you are ready to go. So when you look at the overall picture, counting what you first paid for your equipment and how much you finally get out of it after you have reached the end of production in that field, we still have even a better case for the gas engine. And with modern operation in gas engines, we have constantly made improvements in the gas engine so that the amount of trouble and shut-down you have with engines have become less and less every year. Unfortunately, many users of electric motors use the sheave sizes so that they have a very poor pumping speed and then they have that pumping speed from now on out. Whereas, in gas engines, you can readily change the pumping speed as you find a better pumping for that particular well.

You can do that simply by walking up and adjusting the governor a little bit one way or the other and you can get the proper pumping speed. Now when we take all these factors into consideration—when you consider that we can pump the well with the gas engine like it should be pumped and like its particular requirements of the moment require it to be pumped—we see that we finally wind up with not only less expense but perhaps with more and better production.

Mr. McCaskill: We will take the first question from the electric power side of the table. Mr. Woerner.

Mr. Woerner: I don't know that this is a question as much as it is an addition to Mr. Gatewood's reference to the demand charge. He apparently has demand charge confused with efficiency. When a moter operates at less than its rate of load, it does not affect the demand charge at all. The efficiency of that motor does not register on the meter. You pay for what you use and not for the efficiency of the motor. As to the 75 horsepower motor where they are charging $1,000 a month, if I can multiply, that would be something in the order of 2.3c or more per kilowatt hour. And I would suggest that if they will take that motor off their house circuit and put it on the industrial circuit it will be less expensive.

Mr. Gatewood: Well, I have no rebuttal to that. I did fail to bring out one thing in addition to the 75 horsepower motor. It does have 5 horsepower on a compressor—and of course that would take some more. But he gave me the rates. The rates were less than that but I think that you cannot necessarily always take the rates and tally it out at the end of the month with the bill that you receive.

Mr. Woerner: I have often thought the same thing. If at any time you are unable to calculate these rates, we have people who will be glad to help you with them and if they don't add up right why I am sure they will make such arrangements as are necessary.

Mr. McCaskill: A question now from the gas engine side of the table.

Mr. Platt: On this 95 plus percent electrified property, what percentage of those wells are on cyclic timer.

Answer: Oh, over 90 percent.

Mr. Platt: Then, that is, all of them have a cyclic timer on them.

Answer: All of them have a cyclic timer on them.

Mr. McCaskill: Do we have another question from over here.

Mr. Poore: Somewhere I have missed something on John's remark. He had one and one making three there for a while. I would like to comment just a second on this point about, for example, going out and seeing a 40 horsepower motor and running a curve on it, and probably finding that you only got 5 or 10 horsepower on it. That could possiibly happen and I don't doubt a bit but what it does. It's brought about possibly in several ways. Number 1. The operator of that well no doubt is anticipating, just as he would in the case of an engine, what his ultimate load is going to be on that well over a period of time. And quite frequently many of the operators select their motors or engines on the basis of what their maximum load requirements is going to be, so they put an engine or a motor on the well and they leave it there, rather than changing it out. In the case of a motor, it is possible and has been done in certain instances of utilizing what are called triple-rated motors. In which case the motor can be connected for three different horsepower ratings, which will again reduce your demand charge on that well by proper application of the motor to it. It also reduces your power factor, increases your power factor—or improves your power factor, both of which tend to magnify the losses in your system that are supplying that well. Others—particularly on water flood installations—and that was one of the instances that I think John had in mind when he mentioned that perhaps your pumping pure oil to start with but over a period of time the well makes water, and makes more water as time goes by and you begin to pump more water than you do oil. The 40 horse motor story, I think would stand up just as well against the engine and I am sure a 40 horsepower engine is going to cost a little more than a 40 horsepower motor.

Mr. Slonneger: I would like to ask a question also. Ordinarily, they figure the efficiency of an electric motor to be something in the neighborhood of 80 percent. That is quite true of the electric motor when it is operating under a steady full load and for some little range above and below that. But on a pumping well the load runs from zero, or even negative because you often see the watt meter start turning backward about the 11:00 o'clock position of the crank. So of course at times the motor is generator and puts some current back to the line and then it operates at anything from zero load on up to as much as 1c or even two times its rated load for the rest of the cycle. Now, what is the overall efficiency when the motor is operating that way. If you take the RMS value and the average efficiency, what does it come out to be?

Mr. Poore: Well, the RMS value of course is the main value of the chart primarily. Actually, as far as the kilowatts that you are going to use, it would probably be the average value, John, rather than the RMS value. Because as you point out, if your well is unbalanced for example, it happens, I have seen it happen on a kilowatt hour meter myself, that kilowatt meter run backward—that is, until the power company man gets there and puts something on it to keep it from running backwards. So that the average power on a motor John would fall in the category of perhaps 50 to 60 percent load on that motor, rather than the zero figure. I agree that it goes from zero to a peak above 100 percent load and so the only thing that you could do on that is to take the average value of it—that average value of the horsepower of that motor. You can take a motor efficiency curve and find what your efficiency is for that average horsepower value.

Mr. Slonneger: Well, I have done that on one or two instances but that wouldn't be enough to be conclusive.

Mr. Poore: One or two instances John wouldn't be conclusive on any count.

Mr. Slonneger: The reason I asked that was because of a certain thing that has come up. A certain outfit has taken a dynamometer card on a polish rod and found out that it was so many horsepower. Then they took the horsepower of the electric motor and they figured the output of the electric motor at 80 percent efficiency and when they did that they came out with an efficiency of the pumping unit to be about 75 percent. Of course there was no loss of 25 percent in the pumping unit. The difference was that they had figured the electric motor at an 80 percent efficiency when perhaps its efficiency over this range in variation in load was perhaps much less and they charged that off to the pumping unit. I was wondering whether you had any figures on that taken over a series of dynagraphs.

Mr. Poore: Actually, we — to my knowledge — and perhaps we have been remiss in that particular point ourselves. To my knowledge we haven't actually done that on a large group of wells. Mainly where we have taken tests on wells it has been to determine what the average heating load on that motor is as to whether that motor is overloaded or not. As you know, in selecting a motor, you usually derate the motor somewhat to take care of the cyclic variation in load. And we have been concerned primarily in our tests that have been made at various times in determining what the RMS current is on that motor to determine the heating load on the motor which is the damaging load to the life of that motor. I think one reason why we haven't done too much on the efficiiency side of it is that in almost every instance, provided that motor is selected properly and so forth to begin with, you're going to be running that motor at more than half load and the efficiency on an electric motor—from half load to 1 1/4 load —is pretty much of a flat line. You get a little bit of an elipse there. It's flat on top but it still doesn't drop off too much until you come below half load.

Mr. Slonneger: I think that it drops off at about 75 percent of the rated capacity and part of the time the motor operates that way.

Mr. Poore: Actually John it's more like 50 percent of its rated capacity where the serious drop-off in efficiency shows up.

Mr. Slonneger: Well, the curves that I have had on motors, the electric companies cut them off—the motor manufacturers stop off the efficiency curve when you get about 50 percent load but it's headed downhill pretty fast.

Mr. Poore: Where do you stop off the efficiency curve. What we do, we furnish charts on the engine which shows the number of BTU's per hour at different rates and different speeds of the engine. And you can figure out the benefits. At idling speeds you observe your efficiency which is zero. Quite the same as it is with an electric motor. But ordinarily we have a pretty flat curve after you get above half the rated horsepower of the engine. The engines usually run something in the neighborhood of 10,000 to 12,000 BTU's per horsepower hour depending on the load of the engine and so on and so forth. In the oil field engines we are not particularly interested in the efficiency for the reason that we are interested more in continuous and uninterrupted power. Therefore, we keep our compressions low and do not aim for too high an efficiency. The tendency is now, you know, in automobile engines, to run them at very high compression and that sort of thing, but that doesn't influence me one iota when I am designing an engine for oil field pumping for the reason that we are not interested in that high efficiency. We are interested in the continuous operation of the engine and we do that as a sacrifice with a slight amount of efficiency and since we get gas for nothing it doesn't matter much.

Mr. Poore: Mr. Gatewood's comment and I don't recall it completely. but it seems to me that he made a comment that when you lose power on an electrically operated field or lease, those wells are down for a long time until power comes back, or until you can get them started up again. But in most instances, and I admit there are some instances where it can occur to a greater degree, but in most instances, I think you will find that power outages are of relatively short duration. And even those that do cause any period of down time over a few seconds or few minutes, as soon as that power comes back, there is available on all oil field control equipment, what is called a sequence restarting timer which most wells are being equipped with now, that automatically starts that well back up again and starts each well in sequence, so that you don't try to start too many wells off a transformer bank at one time, nor do you build up any high inrush current or high demand charges against the power company. I think that the down-time occasioned by power outages is held to an absolute minimum—by reason of this device.

Mr. Poore: Well, the only thing that causes your trouble, at least out in this area where there are not enforced power factor clauses particularly by the power company is system losses. Now I grant you with a low power factor you increase your system losses in your transmission line, but that is very easily and inexpensively taken care of by means of capacitors. And quite a few wells out here utilize capacitors for that purpose.

Mr. Slonneger: The power factor of course increases your power losses in your lines and all that sort of thing. There is no question about that at all. To what great effect that is, I don't know. But the point I was trying to make out that many operators think that they are using 15 horsepower for a very small cost. But they are just fooling themselves on that, they may actually use only 5 horsepower and they think they get the 15 horsepower for the cost of 5.

Mr. Poore: I am not so sure it's that they are fooling themselves on that, John, I think in the final analysis it's not necessarily the cost of the power itself— what the power bill amounts to —but it's when they get through bringing in that power cost and the other cost of operation on the lease—of an electrically operated lease vs. a gas engine operated lease, how much does it actually cost them per barrel to lift a barrel of oil, or a barrel of fluid—let's put it that way. And if it's cheaper to do it with electric pumping that's the way they are going to do it, no matter what the power bill is. So I think the power bill is only one factor in this overall cost comparison, John, rather than the main factor.

Mr. Slonneger: I am willing to concede that each type of power has its merits and its demerits both. There are some cases in which it is more economical to use electrical pumping. There are other cases in which it is more economical to use the gas engine pumping. In my book both of them have a place and it's the wise man who chooses the right source of power for the right job. And there are many factors to be considered before you make that decision.

Mr. Poore: For once John and I agree.

Mr. Gatewood: Mr. Poore, I don't believe I used the words long-time on shut down on power falure. I don't believe that I did. If I did, it certainly was an error.

Mr. Poore: Well, the main thing that I wanted to bring out there was that you can get it back on automatically.

Mr. Gatewood: Well, what I had reference to rather was that you would have a number of wells off the line rather than possibly one as in the case of engine failure.

Mr. Poore: Well, I may have misunderstood you.

Mr. McCaskill: Any more questions from the gas engine side?

Mr. Platt: Yes. In these figures we get on comparative cost, since we are stressing labor as such a big increment of the total cost, how many of those engines were equipped with the modern long life devices.

Mr. Athanus: The economics I furnished here were made on a study two or three years ago before the advent of long, long engines. I understand that we have some long run engines on test and I think they have done very good.

Mr. Platt: This might change the whole picture.

Mr. Athanus: I wouldn't say that because I can't answer that. I have no way of knowing. I will say that the operating costs of the long run engine for the period for which we have tested them, which has been on the order of six months to a year, the operating costs have been reduced—oh, I would say 60 percent or something like that. There has been a big improvement on them.

Mr. Platt: 60 percent then would change the figures here the other way around.

Mr. Athanus. That's operating cost—fuel, oil, no maintenance, no overhaul. I mean that is just on these six months to one year tests.

Mr. Platt: That is the point I wanted to bring out.

Mr. McCaskil: Do we have another question from the electric power.

Mr. Athanus: I would like to ask a question. Did I understand Mr. Platt that there is a method of operating gas engines now where you can cycle them.

Mr. Platt: No. we cannot. You can shut them down, but you can't start them.

Mr. Athanus: We think that is very important in our operations.

Mr. Platt: In you operations—cyclic—it would be.

Mr. Poore: I would like to ask one question here and that is—I think this was in Mr. Gatewood's comments—about this safety angle—about getting a shock or something like that on an electrically pumped well. I am quite sure that if you want to get shocked, there is no way that anybody can keep you from getting it, just as easily as there is no way for you to keep a man from sticking his hand in the belts—with guards or anything else. Certainly you can do the same thing in your own home. I have been kicked on my ear sticking my finger in a light socket, too. But I did it deliberately and it was my own fault, so I don't think you are going to do without electric power in your home just because of the possibility of a shock. But to get back to the safety angle, there are certain engines that you still have to crank to start them and I am of the opinion that is just as hazardous, if not more so, than pushing a push button to start a motor. Not all engines are started by starter, are they?

Mr. Platt: All that I know of can be equipped that way.

Mr. Poore: Well, I have seen quite a few in the fields that are cranked and I am asking that question—what percentage are so equipped.

Mr. Gatewood: I don't speak for any particular area and to quote my opinion, practically all of the major producing companies have some starting device on their engines. I don't think that you will encounter very many of the hand-cranked type. Now, I could be wrong on that. I think that most of the campanies use them as a safety precaution.

Mr. McCaskill: Any more questions? Does anyone have any questions they want to ask the people from the floor?

Question: I just want to take a little time. People often ask me in the case of engines what is the relationship between its nameplate horsepower and its actual horsepower. In the case of motors we have a nameplate rated horsepower. We have written there the service factor. The service factor of 1.15 means you can operate that motor within the range not exceeding 15 percent of horsepower rating of the motor nameplate. Now, what is the relationship, or connection, between its nameplate rating and its actual shaft horsepower rating.

Mr. Platt: Well, I know in our instance the nameplate rating, rather the curve range is 65 percent of maximum—the old A.P.I.

Mr. Slonneger: That is a lot of bunk, of course. That depends very much upon how much fly wheel defect you have. I think you may rate your engine right up to its capacity—to the capacity that it will actually take. For instance, if you can put out, well, let us say 30 horsepower a day without injury to the engine, and if you have sufficient fly wheel, you may rate that engine at 30 horsepower on pumping a well. The electric motor, of course, does not have any fly wheel and has to run thru its peaks with actual power supplied from the lines. But the gas engine can operate with—running thru the peaks on the flywheel and when the load drops off into the valley it restores the engines constant horsepower and restores the energy of the flywheel for the next peak. And so we rate an engine with top flywheel effect right up to its actual capacity. It need not be 65 percent. If you have insufficient flywheel effect, then of course you have to have a bigger engine in order to run thru the peaks that comes from pumping a well. But most of the engines in use now—a good many of them—are provided with flywheel based upon that particular consideration. And so the engine goes along at a constant output and the flywheel changes speed to take care of the peak. And we might add to the question, that came up a moment ago about the efficiency of an engine at half-load, we can have just as high efficiency at half-load as we have a full load, provided of course we reduce the engine speed so that we still have a full sized explosion in the engine. For instance, suppose you have for the sake of argument, a 10-horsepower engine and you want to load it for horsepower, you can reduce the speed about one-half and still have the same efficiency as 5-horsepower as you would have at 10-horsepower at full speed. You can't do that with an electric motor.

Mr. Gatewood: I am going to add that the high speed engine doesn't have a large enough flywheel either. We must derate those. Also take into consideration your altitude and your atmospheric temperature. So a nameplate on an engine is just something to work from. It isn't the horsepower delivered at the shaft.

Mr. Slonneger: A lot depends very much of course upon how the original rating was arrived at.

Mr. Gatewood: Ordinarily our engines don't have a horsepower rating stamped on them any place at all. We work from the curve and it is necessary to derate them both for continued duty as well as for your altitudes and atmospheric temperature.

Mr. Platt: In other words, you are not working the engine out against the end of a handle every minute.

Mr. Gatewood: That is right.