BRIDGE

eta kappa nu

Electrical Engineering Honor Society
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OUR COVER
The Eiffel Tower of Paris introduces our special feature article starting on page 6.

The BRIDGE is published by the Eta Kappa Nu Association, an electrical engineering honor society. Eta Kappa Nu was founded at the University of Illinois, Urbana, October 28, 1904, that those in the profession of electrical engineering, who, by their attainments in college or in practice, have manifested a deep interest and marked ability in their chosen life work, may be brought into closer union so as to foster a spirit of liberal culture in the engineering colleges and to mark in an outstanding manner those who, as students in electrical engineering, have conferred honor on their Alma Maters by distinguished scholarship activities, leadership and exemplary character and to help these students progress by association with alumni who have attained prominence

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The Alton B. Zerby Outstanding Electrical Engineering Student Award for 1984 was presented to Michael Joseph Hargraves at the semi-annual meeting of Eta Kappa Nu held at the Marriott Lincolnshire Resort in Lincolnshire, Illinois in August 1984.

Michael was nominated by the Delta Epsilon Chapter at Ohio University where he achieved an overall grade point average of 3.8 out of 4, easily putting him in the upper few percent of his graduating class. In addition to being honored with membership in Eta Kappa Nu, Michael also received membership in Tau Beta Pi and Phi Kappa Phi.

After a ten year career as a high school instructor, teaching physics and mathematics, coaching football and being named "Outstanding Teacher" and being a father of three small children, Michael joined the U.S. Air Force in 1982 as a second lieutenant. As an officer on active duty he attended Ohio University under a special program offered by the U.S. Air Force. Michael intends to pursue an MSEE degree in the near future.

Michael's travel expenses to the meeting were paid from the Alton B. Zerby Memorial Trust Fund and he received a $500 cash gift from the Carl T. Koerner Memorial Trust.

Named for Honorable Mention Awards were John Gregg of Pennsylvania State University, Ernest Haache of the University of Texas at Arlington, Holly Heine of Clarkson College, Terry Koelbl of the University of Alabama Huntsville, and Virginia Lessmann of Virginia Polytechnic Institute and State University.

Robert Kennerknecht representing the Los Angeles Alumni Chapter of Eta Kappa Nu acted as emcee for the night. The Los Angeles Alumni Chapter conducts the Alton B. Zerby Outstanding Electrical Engineering Student Award program for Eta Kappa Nu National under the committee chaired by Marcus Dodson. The 1984 committee members were Rupert Bayley, Stuart McCullough, William Murray, Robert Kennerknecht, and Richard Cockrum.

The final selection from the ten finalists chosen by the committee is determined by an independent jury of acknowledged leaders in Electrical Engineering. Members of the 1984 jury were Paul B. Jacob, President of Eta Kappa Nu, and Audrey J. Smith, Chairperson of the Los Angeles Area Council of IEEE.

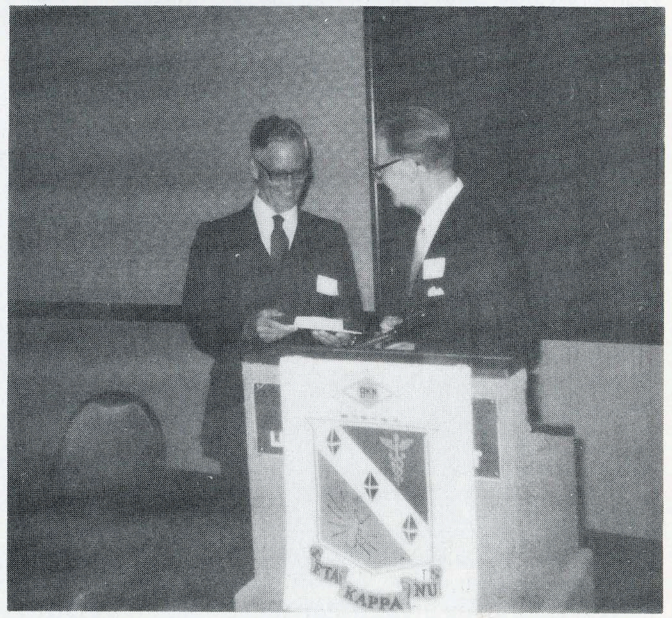
After closing the ceremony, Robert invited everyone to the theatre to enjoy a live Broadway play "A Day in Hollywood—A Night in the Ukraine" a delightful look at the comedy of the Marx Brothers and Hollywood during it's early years.

The Los Angeles Alumni Chapter wishes to recognize and applaud the many many years of loyal service performed by Larry Hamilton. Larry chaired the Alton B. Zerby Award Committee from it's inception nearly twenty years ago until his untimely death early in 1984. He will be missed by all of us.

Student.....
AWARD DINNER

Text By
Richard Cockrum

Photos By
Earl Steele



The First Time I Saw Paris

—— part five ——

Stories of Paris

As I drifted around Paris I tried to look at the Eiffel Tower as often as I could. I was trying to decide what I thought of it. Of course I have seen pictures all my life but they are of no help. It was built for the Exposition of 1889, and there was an immediate storm of protest from the aesthetic establishment. Among the 300 who signed a protest were Gounod, Dumas, Maupassant, and numerous others of the main line. However, after it was built and people became used to it, it received praise from such as Cocteau, Duffy, Utrillo, Seurat and others. The story is told about the time William Morris very nearly cloistered himself in the restaurants of the Eiffel Tower, not only taking all of his meals but even doing much of his writing there. "You're certainly impressed by the Tower," someone once remarked to him. "Impressed?" said Morris, "I stay here because it is the only place in Paris where I can avoid looking at the ugly thing." That was not my final opinion. I think it is very beautiful and especially in the matter of its gracefulness.

The tower was to stand only 20 years and then be torn down. It was saved by technology—specifically, its usefulness as a radio tower and weather station. Now, of course it is responsible for bringing in more tourist money than any other one structure in Paris. Three and one half million visitors pay their coins every year.

I have had no connection or relationship with the Eiffel Tower but I had a very dear friend who did. I say *had* a friend because he is dead now. His name was Raymond Heising. He was the Western

by PAUL K. HUDSON
Editor — Bridge

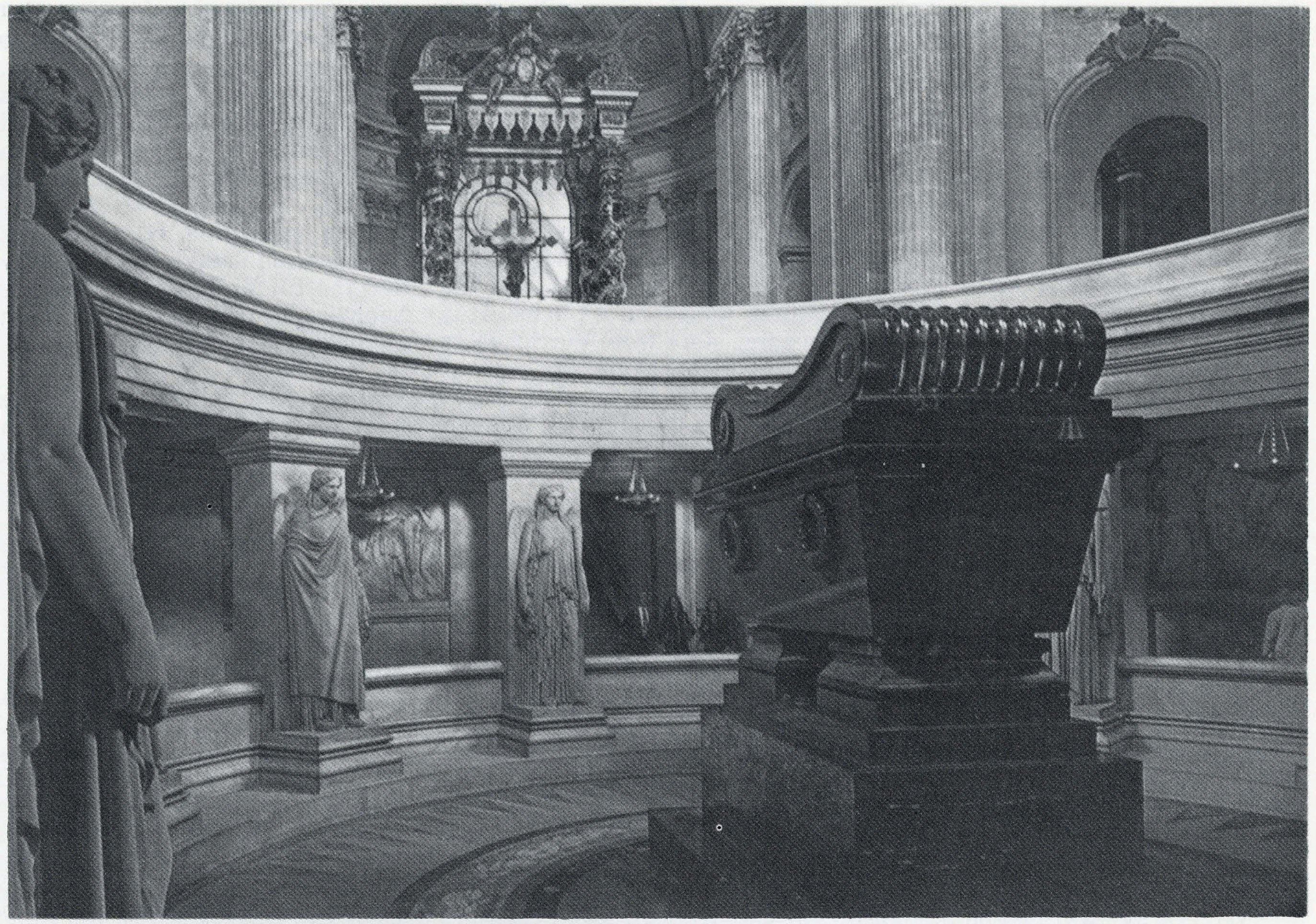
Electric engineer who designed and built the transmitter that achieved the first trans-Atlantic radio-telephone communication. The transmitter employed a Navy tower in Arlington, Virginia and the receiver was located in the Eiffel Tower in Paris. Ray had quite a number of inventions including Plate-Modulation, Class-C Amplification, and Vacuum-tube Voltmeters. Shortly before he died he presented to me as a gift one of his most treasured possessions—a box-full of photographs and documents relating to the trans-Atlantic tests and the transmitter he designed and built for them. As he handed it over, he said to me, "You have my permission to do with them whatever you wish." I hope to publish them someday when the right time presents itself. One of the photographs appears with this article.

The last time I visited with Ray he told me a most unusual story relating to the Eiffel Tower. Dr. Lee DeForest became famous for inventing the triode tube and was often called, by the American press, *The Father of Radio.* Because of his fame and availability, the press would often contact him for comments whenever something new was developing in the field of Radio, even though he was not directly involved. Of course he generally knew what was taking place and could offer accurate information. However, he had no connection with Western Electric or Bell Laboratories, and therefore knew nothing at all of the details of the installations at Arlington and Paris. Anticipating the future calls of the press, he went to Arlington to obtain information. It was the policy of W.E. and Bell to maintain complete control of all press releases and so the W.E. engineers did not tell him anything. He then went to Paris and was drifting around the Eiffel Tower when the Paris Police came to the conclusion that he was a German Spy, and placed him under arrest, or started to. The first World War was in full sway at the time and, during the night, from the Eiffel Tower, artillery shells could be seen exploding on the battlefield. However, some of the W.E. Engineers saw the arrest and went over to the police and told them that it was O.K. for DeForest to stay there. But they still did not tell him anything about what was going on. Ray chuckled when he came to the punch-line: "I don't think DeForest ever realized how close *The Father of Radio* came to spending the night in a Paris jail."

Near the Eiffel Tower is the Military School where Napoleon Bonaparte was educated, and the Invalides where he is buried. It is only a few steps from the School to the Tomb, but Napoleon sort of took the long way around. I was not prepared for the tomb. I was not surprised that it was grand, but I was overwhelmed by how grand it was. The Taj Mahal is supposed to be the grandest tomb in the world, and I suppose it is. However, it was built for a woman—Mumtaz Mahal—and, in my opinion, based on photographs I have seen, it is quite feminine. Napoleon's tomb is definitely masculine. So, with that qualification, maybe I could say that the Taj Mahal and Napoleon's tomb are the two grandest tombs in the world and are of equal elegance.

The tomb is cylindrical with the sarcophagus on a raised platform in the center. The dome of Heaven

A.T. & T. Engineers who participated in the first trans-Atlantic Radio-Telephone communication in 1915. E.B. Webb is holding the microphone that was used at Arlington and H.E. Shreeve is holding the loudspeaker that was used in the Eiffel Tower at Paris. Second from left in the back row is Raymond A. Heising who built the transmitter and who gave this photo to your BRIDGE Editor. On his left is R.V.L. Hartley who invented the Hartley Oscillator.



above it is so high that it is almost like being buried outside. There are two ambulatories for viewing, one above the other. Around the top one are side tombs, like side chapels in a Cathedral, so elegant and breathtaking that any one would be worth a trip to Paris. The one for General Foch is stunning.

As I walked around the lower ambulatory, I came upon a very humble and unpretentious grave. It was just a grave stone in a niche, but I was astonished to find it. It was of a 21 year old boy—I guess I should call him a young man. The reason I was so surprised was because I had always thought that he had been buried in Vienna. In fact I am all but certain that he was buried in Vienna and so it must be that his remains were removed from there some time later and taken to Paris. Although he was only 21 when he died, he had a most fascinating history. Needless to say, he was a very important person or he would not have been buried in Napoleon's tomb, a poor grave on the lower level, notwithstanding.

The young man was born in 1811 in Paris. When he was three years old he was taken to Vienna where he lived the rest of his life. When he grew up, all the women of the court fell in love with him. A married lady fell hopelessly in love with him and he with her. She did not like her husband and made no secret of her love for the young man. At age 20 he became ill and she moved in with him in order to try to nurse him back to health. But neither fame nor pleasure can stay the hand of Death, and so about a year later he died in her arms. A few months after he was dead, she delivered a son. By her own admission, the young man was the father. And now it is time to tell who these people were.

The Tomb of Napoleon Bonaparte in the Invalides, Paris.

The young man in this story, who came from Paris as a child and who is buried in the humble grave in Napoleon's Tomb, was Napoleon II, the son of the Emperor. His lover was Sophia, the wife of an Archduke of Austria (part of the Franz Josef clan). And the son she delivered, well, he is the interesting one. He was not Napoleon III even though his father was Napoleon II. The law reads that when a married woman delivers a child, no matter who the father is, the child belongs to the husband. So—instead of becoming Napoleon III he became an Archduke of Austria. Now the story comes closer to home. This special young man, when he grew up, married a

The Dramatic golden equestrian statue of Joan, the Sweet Maid of Lorraine, in the Place des Pyramides, on the Rue de Rivoli, Paris. →

pretty girl named Carlotta, resigned his claim to the Austrian Throne, and moved to Mexico. He became the *Emperor Maximilian of Mexico.* Maximilian and Carlotta—romantic names—is there anyone who has not heard of them? A short time later Maximilian was captured and shot to death by one of Juarez's firing squads. When they stood him up he asked them to wait a minute. He took a gold locket out of his pocket, opened it, and looked at it for a little while. He then closed it, put it back in his pocket, waived his hand and they killed him. The locket contained a picture of Carlotta. The next time you are in Washington you may, if you wish, view the 24 carat emerald stone from Maximilian's Imperial Ring that is on display in the gem collection of the Smithsonian Institution.

There is an interesting story about Napoleon II that I expect does not get into the French History books. When he was a baby, his father, the Emperor, loved him dearly and carried him around in his arms and kissed him. His mother did not do that and she criticized the Emperor with the remark, "Who in the world could kiss a baby?" The Emperor cried out, "My God, I married a womb."

Napoleon III was the nephew of the Emperor—the son of his brother Louis. He had some good qualities, such as his efforts, via Haussman, to straighten out the city and make it more livable. But he is remembered best for his many escapades. He was a real alley-cat. You know the story about all the movie directors and producers who say to pretty young women who want to get into the movies, "I can get you into the movies—here is all you have to do." Napoleon III invented that line. He would say to a beautiful young woman, "How would you like to be the Empress of France— here is all you have to do." In the Paris Library is a diary of one of these ladies. The entry on a certain date reads, "Tonight, in half an hour, I became the Empress of France." However, to her amazement and disappointment, the next night and the next and the next, other beautiful women were busy becoming the Empress of France.

As interesting as Napoleon III was, he was not the most interesting scoundrel of Paris. That honor goes to a man who lived in the 15th century and was so evil he would make Napoleon III look like a saint. He started his life of crime by stealing some gold coins from a church and killing a Priest named Philippe Chermoye. He then became real busy. Every night, just for entertainment—a means of passing the time—he and his friends would go out on the town and commit murders, rapes, thefts, arson, and anything else they could think of. He was caught and imprisoned many times, and beat up more than a few, but his unbelievable good luck kept him from being executed.

Why would we here mention such a terrible man? There is a very good reason. He not only was one of the most evil men in the history of France, but also, one of its greatest poets. His name was Francois Villon. His poetic masterpiece was *The Great Testament* but his most memorable poem was the *Ballad of the Dead Ladies.* One of the hauntingly beautiful verses is:

And Joan, the sweet Maid of Lorraine
Whom the English burnt at Rouen
Where, where is she Sovereign Virgin
And where are the snows of yesteryear?

Villon was expelled from Paris for the last of several times in the winter of 1462-63. On a bleak and bitter January morning he passed through the Gate of Saint Jacques and wandered off into the *Great Forever.* He did not know where the snows of yesteryear were but he was well informed on the snows of that year—he froze to death in them. His body was never found but it is easy to guess what happened to it.

I do not know what traces there are in Paris of Joan, *The Sweet Maid of Lorraine.* A good historian probably could find lots of them. But there is one for all to see. It is the beautiful and dramatic gold statue of her in the Place des Pyramides on the Rue de Rivoli, just across the street from the Tuileries Gardens. (see photo) I have always wondered what Joan was like—what her personality was like—what she looked like, etc. Beauty in those days was not measured the same way it is today. Based on the statue, I think she was quite attractive even by today's standards. Although Saint Joan died in 1431, people and groups of people still make pilgrimages to the statue.

BETA UPSILON, University of Kentucky — Beta Upsilon Chapter at the University of Kentucky is striving to become a people serving organization. Under the leadership of newly elected president Lewis Alexander, projects engaged in are geared to serve the members as well as the engineering student body.

Engineering students benefitted from a job search program presented by Alcoa and arranged by Eta Kappa Nu. On November 28, engineers from Alcoa, Steve Hillock and Don Pettit, talked to the students about the interviewing process, plant trips, and projects a recently hired engineer may expect. To further help the student, mock interviews were held by Alcoa's recruiters. Interviews were video-taped and critiqued. Overall, the program provided an excellent opportunity for students to gain interviewing skills.

This semester, chapter functions and activities have included tutoring sessions and an electrical engineering departmental picnic planned in conjunction with IEEE. Under Lewis Alexander, the other officers are Wayne Nation, Richard Losert, Vicki Atkins, Karl Horlander, Stephen Schaefer and Leslie Collins. The group held initiation on November 19; at that time thirty-four applicants became members.

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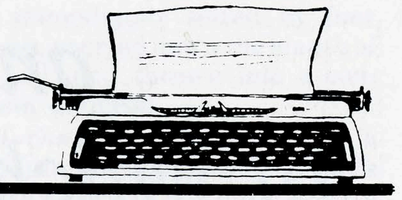
High Five



QUESTION
You go to the lake for some water. You want exactly four quarts, but you have only a three quart can and a five quart can. How will you get four quarts? There are many answers to this problem—see how many you can find.

I've got a good memory for forgetting—(Stevenson)

I'd give my right arm to be ambidextrious—(Graffito)

God gave us memory that we might have roses in December.

Those who live in stone houses should not throw glass.

And there was the identical twins who could not tell each other apart.

"Hammond, do you plead guilty?"
"I couldn't say, your Honor. I haven't heard the evidence yet."

It is well to remember that the entire population of the Universe, with one trifling exception, is composed of others.

You can observe a lot just by watching.

He does not have a single redeeming vice—(Wilde)

A rose by any other name, department—THE ANCIENT MARINER would not have been so well received if it had been called THE OLD SAILOR.

Then there was the violinist who was advised by his surgeon that he'd have to undergo an operation.
"But Doctor," he said, "I have concerts booked far ahead. If you do operate, could I be assured that I'll be able to play the violin in two weeks time?"
"Undoubtedly!" assured the Doctor. "The last patient on whom I performed this operation was playing a harp within twenty-four hours!"

A research organization making a study of juvenile delinquency, telephoned fifty homes between 9:30 and 10:30 at night to ask parents if they knew where their children were. Half of the calls were answered by children who had no idea where their parents were.

A man rarely succeeds at anything unless he has fun doing it.

FOOTBALL QUIZ
If the quarterback whispers a change of play at the line of scrimmage, he is calling:
[a] an inaudible. [b] time out. [c] for help.
The free safety is:
[a] unmarried. [b] over 21. [c] out on parole.
The weak side:
[a] spends too much time in the library. [b] eats prune yogurt. [c] is the one you give the points to.
A safety blitz:
[a] is used on third down. [b] holds the corners of the diaper together. [c] is very tasty with sour cream.
A nose guard's job is to:
[a] prevent sunburn. [b] sniff the cork. [c] be Karl Malden's hat.
The two-minute warning is:
[a] when they sell radial tires. [b] a good idea for parking meters. [c] a cry for mercy from the back of the restroom line.
The pulling guard is:
[a] the cornerback's nightmare. [b] a dental assistant. [c] the one they hook the wagon to.
The theme song of the Washington Redskins is:
[a] off-key. [b] Hail to the Chiefs. [c] never sung in Dallas.
The over and under is:
[a] 43. [b] Walter Payton's salary. [c] John Madden's waistline.
The suicide squad is:
[a] found on the Expressway at rush hour. [b] moonlighting cops at a rock concert. [c] the dinner crowd at a Mexican restaurant.

Dad: "Well, son, what did you learn in school today?"
Son: "I learned how to say, "Yes, sir," and "No, sir," and "No, ma'am," and "Yes, Ma'am!"
Dad: "Really?"
Son: "Yeah!"

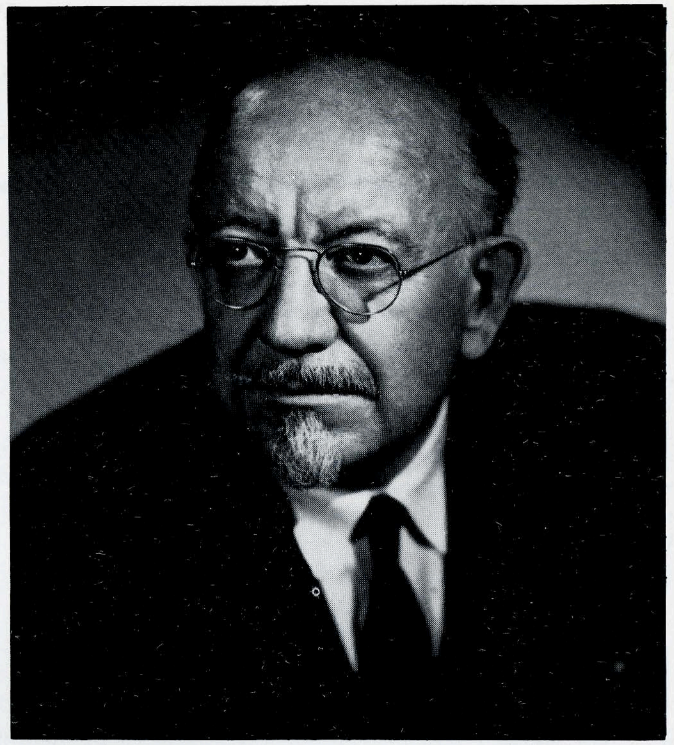
The best way to forget your own problem is to help someone solve his.

Thou wast all that to me, love,
For which my soul did pine—
A green isle in the sea, love,
A fountain and a shrine,
All wreathed with fairy fruits and flowers,
And all the flowers were mine.
Poe

and part of which I was

Recollections of a Research Engineer

George H. Brown



INSTANT ROYALTY

One sunny morning in May, 1970, my wife and I arrived at Shannon Airport from New York with the help of Aer Lingus. After a few hours sleep at a nearby hotel, we drove our rented car around the countryside with stops at Keane's Pub and at the Old Ground Hotel to witness a dancing session by beautiful Irish children. We had heard of the medieval banquets at Bunratty Castle, a fifteenth-century towered fortress midway between Shannon Airport and the town of Limerick in County Clare. I telephoned the castle, ascertained the time of the affair, and reserved two places at dinner.

At the appointed hour, we entered the castle and were greeted by a charming young lady in medieval costume who escorted us up several flights of stone and wooden staircases to the very top floor of the castle. Here we found many other guests crowded around a huge kettle of warm mead. Our young guide told us that she and a number of other young men and women were students of drama and music at Trinity College in Dublin and that they spent two months at Bunratty Castle wearing fine costumes, serving the dinner, and entertaining the guests with song and dance.

About two hundred guests were in the large room, imbibing mead, admiring the tapestries and the young wolfhound stretched lazily near the door, and getting acquainted.

In the midst of the festivities, my wife and I were approached by a young man who seemed to be in charge and we were asked if we would act as the Lord and Lady of the castle for the evening. (Technically, the Earl and Lady of Thomon.)

We graciously accepted the honor and almost instantly were seated on a pair of huge oaken thrones with crowns on our heads. A photographer was summoned to record the instant bluebloods.

When it became time to dine, my wife and I were individually escorted down the stairs to a large banqueting hall where I was seated on another large throne at the dinner table with my wife in a more modest seat at my left. Then the other guests were permitted to join us. The photographer continued his work.

As the most important Lord and Lady, we had our own waiter and waitress as well as an official taster who played his part by clutching his throat and staggering around the hall each time he tasted a morsel of my food.

The evening proceeded with music, singing, and dancing by the professionals. We were served what was purported to be a fifteenth-century menu and we were given the completely inadequate tools with which to attack the food.

My taster whispered that I was expected to address the gathering at the end of the meal. He also added that a coach driver for a group of German tourists had agreed to take part in a charade. Accordingly, I stood before my throne, addressed the dinner guests and complimented our gracious hosts.

At the end of my remarks, I said, "It has come to my attention that one of our guests has been trifling with a lady of the castle. Throw that man into the dungeon."

I pointed to the coach driver who was immediately seized by four lackeys, carried down the length of the hall, and thrown into a convenient dungeon.

As the door clanged shut, a German lady shouted, "That's Klaus. He drives our bus. How are we getting home?"

As the good natured affair was ending, I was approached by the photographer who asked for an address to which he could send copies of the pictures. Since we were continuing to the continent, I gave my office address at RCA Laboratories.

When I returned there several weeks later, my secretary said, "When I opened that envelope, I just did not know what to think!"

Assistant BRIDGE Editor Dr. George H. Brown was formerly Executive Vice President for Research and Engineering for the entire RCA Corporation

In Memoriam

They are not long, the days of wine and roses:
Out of a misty dream
Our path emerges for a while, then closes
Within a dream.
(Dowson)

It is with deep sorrow that we record the passing of Assistant Bridge Editor Marcia Peterman who fought a good fight but finally lost a hopeless battle against cancer. Marcia had her own page in each issue of Bridge for the last fifteen years under the heading MERRY MOMENTS WITH MARCIA. This was so successful that other magazines requested permission to use the material on a regular basis.

Marcia was a very kind person whose sweetness and gentleness were almost child-like. Her happiness of heart made her a joy to be with. She was not a regular member of Eta Kappa Nu but was so helpful to Alpha Chapter that they made her an Honorary Member of the Chapter. She served as Secretary to the Head of the Electrical Engineering Department at the University of Illinois for many years.

Marcia and I often had occasion to communicate with each other by notes or letters but we almost never signed our right names. I usually signed my letters "Charles Boyer" and ended them by saying, "Come with me to the Casbah, the grocery store, the skating rink or anyplace else that would please you." She usually signed her letters "Elizabeth Taylor."

One afternoon, eight years ago, I was trying to think of some way to thank Marcia for all the nice things she did for Headquarters, Alpha Chapter, and all the other people. At that moment I considered that maybe the best thing to do was to write a letter and tell her how much she was appreciated. So I made up a story that told her this within the narrow limits of my circumscribed ability. After a few weeks or months I completely forgot about it. I did not know that Marcia preserved the letter among her souvenirs. After she was gone, the Pastor who was invited to preach her funeral sermon found it among her things and decided to read it as part of the sermon. As a final tribute to Marcia, and with all humility, I have decided to share the letter with anyone who would care to read it.

Paul K. Hudson
Executive Secretary and Editor

MARCIA PETERMAN

August 1977

Dear Lovely Marcia:

Whenever I get so busy that I do not know what to do next I usually go for coffee. Or, if the weather is nice I take a little ride on the country roads outside of town. On a beautiful afternoon last May I took a ride down South First Street. When I had gotten well out of town I parked the car and started walking down the road. If you have never done this you can't imagine how much pleasure it is. Everything is quiet except for a car once in a while, and there are all sorts of wild flowers along the road. Many farmers do not mow beside their land, especially early in the year. Quail and other birds and animals live there and often run across the road. After a while I came to a beautiful wild rose deep in the weeds where it could not be seen except by someone walking. I went over to it and said:

"Hi pretty little wild rose, do you mind if I just call you "Rose."

She said, "What's the matter with you, don't you know that flowers can't talk?"

I said, "Well you are talking—you just answered me."

She said, "You tricked me, I was not expecting you to say anything to me. People are not supposed to know that we can talk. How did you know?"

"Oh, I have been talking to flowers all my life."

"You have? When was the first time?"

"I was about four years old. I saw a Tiger Lily for the first time and I just stood and looked at it for a long time—maybe an hour. Finally the lily spoke to me and said,

"Little boy, why are you staring at me so much?"

I said, "Because I think you are beautiful."

She said, "Wouldn't you rather be playing with your toys?"

"I don't have any toys, but even if I did, I would rather look at you."

"Well now, that is a very nice thing to say to a lady. You have just made my day. However, you must learn not to stare at girls too long at any one time."

"In a little while you will be gone and then I will never see you again. What will happen to you?"

"Why, I will be going back to Flowerland—that is where all flowers go when they leave here. It is beautiful there and everyone is happy."

"Do people ever go to Flowerland?"

"Of course, there are many there. But the only ones who are allowed are the ones who are comfortable there—the people who love flowers, music and see the beauty of doing nice things for others."

"Well I will leave you now Lily—my mother will wonder what has happened to me—but I will remember you always."

"That was very sweet" exclaimed Rose, "I am very glad that Lily spoke to you and you found out that we could talk."

"Yes so am I, but there is one thing that still bothers me. You are very beautiful, Rose, and smell real nice, but you are growing here in the weeds and no one ever sees you. I am the only person who will ever see you and that is because I like to walk along the roads."

"It does not matter at all. Don't even think about it."

"What do you mean, it doesn't matter?"

"Just that—it doesn't matter. I know who I am and what I am and it doesn't matter if no one ever sees or appreciates me."

"Well, if you say so. But it seems to me that your life has no meaning."

"It certainly does have a meaning—it has the most beautiful meaning that any life can have."

"I don't understand at all. Tell me about it."

"There is no use. You are just strange. You do not have any faith. If your life is to have meaning you have to have faith."

"Faith in what, Rose?"

"Faith in the rightness of things—faith in the sun when it is hidden—faith in the Spring when it is gone—faith in the rightness of the world—faith in the rightness of life. If you have that kind of faith you just do not worry about the fact that you are growing in weeds and no one ever sees you."

"Well, I guess you're right—I guess you have peace of mind—but that does not explain any meaning to your life."

"The meaning of my life, Sir, is to make every moment of every day of my life just as beautiful as I know how to make it—but beauty only for the sake of beauty and not for any praise or gain. That was what I was put here to do and I do it as best I can."

"You are very lovely Rose, and I am so glad I met you—I'm glad I didn't live out my life without knowing you."

"Thank you, Sir and now as it is starting to get late I think I will fold my petals and take a short Summer's nap."

Dear Sweet Marcia—you are like Rose in every way. You are very beautiful in every way and all your life you have tried to make every moment of every day just as beautiful as you know how. And you never looked or cared for any thanks or recognition. You are one of a kind—world-class wonderful and first-chair nice. May God love you and keep you always.

Love,

Paul

Outstanding Chapter Activities Award

Selected are:

Purdue, Texas at Austin, Hawaii, Michigan Tech, New Mexico and Colorado

by ALAN LEFKOW
Chairman

For the third year in a row, Purdue University's Beta chapter has again won top honors in the annual Outstanding Chapter-Activities Award competition. Beta chapter was chosen as National winner from among dozens of competing chapters based upon its outstanding program of activities for the academic year 1983-84, the Chapter Award Committee announced. Also singled out for recognition were Psi chapter at the University of Texas, and Delta Omega chapter at the University of Hawaii. Both of these chapters have received recognition in previous competitions. Last year, Delta Omega chapter was an Honorable Mention winner and Psi chapter was a Certificate of Merit winner. The committee also presented Certificate of Merit recognition for 1983-84 to Beta Gamma chapter at Michigan Technological University, Delta Omicron chapter at the University of New Mexico, and Rho chapter at the University of Colorado.

As the Outstanding Chapter-Activities Award begins its 49th year, it continues to be unique among the many awards presented by Eta Kappa Nu. The Award is presented to members who have achieved excellence working in concert as a college chapter. Award winners are chosen on the basis of their annual chapter report submitted in the summer and fall following the end of each academic year. The judges review the reports in the winter and announce their decision in the spring. National and honorable mention winners receive engraved plaques to signalize their achievements. Certificate of Merit winners receive appropriately inscribed documents.

Outstanding chapters distinguish themselves on the basis of exemplary service to their department, school and community. Although the OCAA brochure sent annually to each chapter describes a variety of projects chapters pursue, new and interesting activities show up in each competition and are worth mentioning. Last year, for example, Psi chapter organized an Easter Egg Hunt for mentally retarded deaf children. Chapter members ran the egg hunt and helped the children prepare and decorate the eggs the night before. Another chapter, Gamma Theta, at the University of Missouri, runs an E.E. Hobby Club for students. The chapter solicits equipment donations and parts for use by the students in their own electronic projects. In a more academic vein, Theta Kappa chapter at California State University has undertaken the design and construction of a small, solar tracking, microprocessor controlled, solar power plant. The chapter succeeded in obtaining funds from the University and has already started construction of the plant.

These are but a few of the many activities that distinguish Eta Kappa Nu college chapters on and off campus. The Award Committee, along with all of Eta Kappa Nu, congratulates the winners on their mark of distinction and achievement.

New Alumni Chapter in Texas

Eta Kappa Nu's newest Alumni Chapter, the Lone Star Alumni Chapter of Austin, Texas, received its beautiful new charter on November 30, 1984. The special presentation was made during the fall initiation banquet of Psi Chapter at the University of Texas.

Dr. Russell E. Lueg, Head of the electrical engineering department at the University of Alabama and a Past International President of Eta Kappa Nu made the presentation. The Charter was accepted by Laureen Parker, the Lone Star Alumni Chapter's Chairman of the Board of Directors.

Other Board members present were Gary Abbott, Bob Rogers, Mitchell Longley, and Gary Morrison. James Gaidry, another Founding Member and Past Board Chairman, recently moved to San Francisco and was unable to attend.

The International Board of Directors has assigned the new Alumni Chapter a special endeavor. Mr. Norman Carson, an International Director of Eta Kappa Nu has donated a very substantional sum of money to Eta Kappa Nu to establish a Trust, the proceeds of which will be used each year to make awards to Outstanding Junior Electrical Engineering Students. All Chapters will be invited to make nominations and the Lone Star Alumni Chapter will be in charge of selecting the winners.

The Early Days of...

THE TRANSISTOR

by JOHN BARDEEN

The point-contact transistor, the first bipolar transistor, was discovered in a program of basic research on solid state physics initiated at the Bell Telephone Laboratories just after World War II. The program was due in large part to M. J. Kelly, who was director of research and later president of the Bell Laboratories. He felt that one could improve the properties of materials from an understanding of their electronic and atomic structure brought about by application of quantum mechanics. The group formed to work on the program included physicists and chemists as well as theorists with an understanding of the quantum theory of solids. The basis for a theoretical understanding of solids had been developed in the late twenties and thirties but generally there was a wide gap between theory and experiment.

Semiconductors were one of several areas the group was involved in; others being magnetism, piezoelectricity and dielectrics. There was a distant hope of using semiconductors to make an amplifying device to replace a vacuum-tube triode. A triode is essentially an electrical valve in which a voltage applied to one electrode can be used to control a current flowing between the other two in such a way as to produce amplification of an electrical signal. The finite lifetime and unreliability of vacuum tubes was limiting the complexity of circuits that could be used in the telephone system.

The head of the semiconductor group was William Shockley. The principal experimentalists were Walter Brattain and Gerald Pearson. A physical chemist, Robert Gibney, was added a little later. I joined Bell Laboratories to work with the group just after the end of the war in late 1945. I had worked on the theory of metals before the war but had done little work on semiconductors. I became interested in semiconductor problems through associations with Brattain, Pearson and Shockley. None of us had worked on semiconductors during the war, so we formed a study group to learn about the subject and met at least once a week.

A sound theoretical foundation for understanding the properties of semiconductors was available from work done during the 1930's based on the Bloch theory of energy bands for electrons moving the

Dr. John Bardeen is Professor of Electrical Engineering and Physics at the University of Illinois. He is the only person ever to receive the Nobel Prize twice in the same field. The first was for the Transistor and the second was for the Theory of Superconductivity. He was made a member of Eta Kappa Nu as an undergraduate at the University of Wisconsin and was later made an Eminent Member by the Board of Directors.

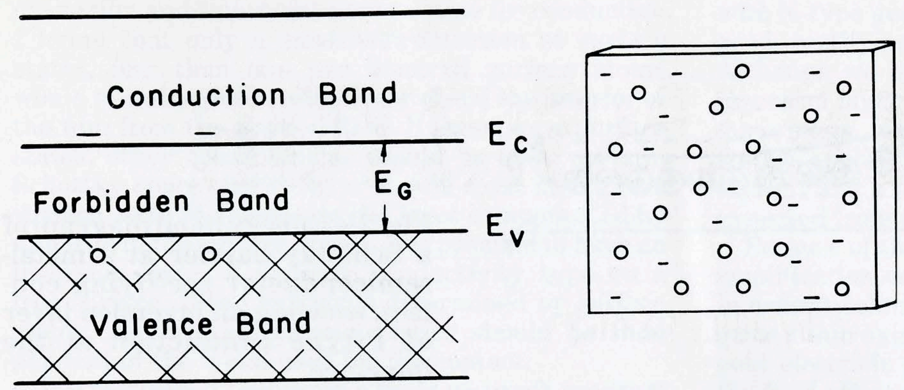


Fig. 1—Energy band diagram of an intrinsic semiconductor with equal concentrations of conduction electrons and missing electrons or holes in the valence band. As shown schematically on the right, the negative conduction electrons and positive holes form a neutral plasma.

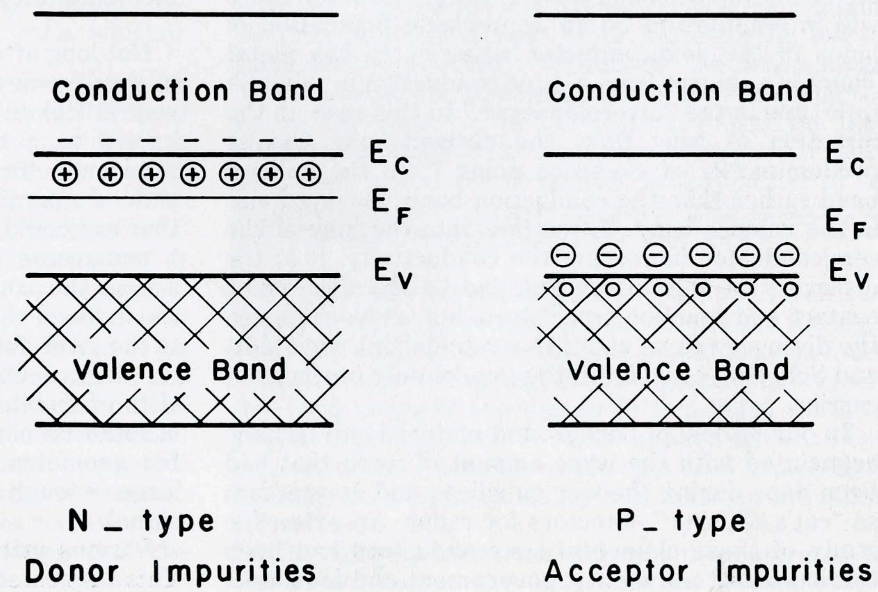
periodic field of a crystal lattice. In developing his theory, given in 1928, Bloch was concerned primarily with metallic conduction. In 1931, Alan Wilson adopted the band theory to semiconductors. In the ideal crystal at absolute zero, the valence electrons that bond the crystal together completely fill a band of energy levels for the electrons called the valence band. There is an energy gap to the next higher band called the conduction band (Fig. 1). Conduction can take place in two different ways, by electrons in the conduction band and by missing electrons or holes in the valence band. The holes behave in all respects like particles of positive charge.

At high temperatures, electrons may be thermally excited from the valence to the conduction band, so that there are equal concentrations of conduction electrons and holes. Such conduction is called intrinsic. As illustrated in Fig. 1, the electrons and holes from a neutral plasma of mobile charges. Electrons may also be excited from the valence to the conduction band by absorption of light of appropriate frequency, giving rise to photoconductivity. Brattain and I discovered another way of increasing the concentrations of electrons and holes, by current flow from an appropriate contact. This is the principle of bipolar transistor.

Wilson also recognized that carriers can be introduced by impurities that go into the lattice in the form of positive or negative ions, as illustrated in Fig. 2. The charge of positive ions (called donors) is compensated by electrons in the conduction band. Since the carriers are negatively charged, semiconductors with donor impurities are called N-type. If the impurities are negatively charged, the charge is compensated by positively charged holes in the valence band and the semiconductor is called P-type. Impurities in parts per million or less can have a significant effect on the conductivity. Conduction introduced by impurity ions is called extrinsic.

It has long been known that a contact between a metal and a semiconductor can be rectifying, but an adequate explanation was not given until the late thirties by N. F. Mott and more completely by W. Schottky. Some of Schottky's papers with his co-worker, Spenke, did not become available in the West until after the war. Shottky's picture of the energy bands in the vicinity of a metal in contact with an N-type semiconductor is shown in Fig. 3, with the space direction perpendicular to the contact. An appreciable energy, X, of the order of 0.5 eV, is

Fig. 2—Energy band diagrams for N-type and P-type extrinsic semiconductors. The charge of the free carriers (electrons or holes) is compensated by an equal concentration of ionic impurities.



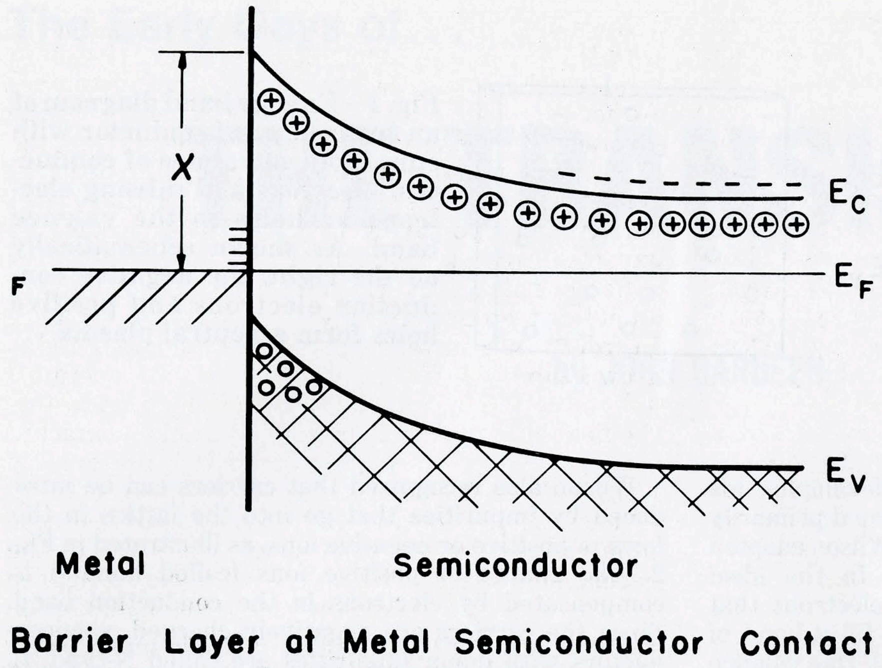


Fig. 3—Energy band diagram of a Schottky barrier at a metal-semiconductor rectifying contact, showing an inversion layer of P-type conduction at the interface.

required to take an electron from the Fermi level, the energy of the uppermost occupied levels of the metal, and place it in the conduction band of the semiconductor. There is a region of positive space-charge from uncompensated donor ions in the semiconductor adjacent to the metal, with a resulting change in electrostatic potential. The direction of easy flow is that with the semiconductor negative with respect to the metal; a negative voltage raises the levels of the semiconductor relative to the metal and allows flow of electrons over the barrier into the metal. With a positive voltage, electrons must surmount the barrier, X, to enter the semiconductor; this is the direction of high resistance. Signs of carriers are reversed for a rectifying contact with a P-type semiconductor.

If, as illustrated, the barrier is such as to bring the top of the valence band close to the Fermi level, there will in equilibrium be an appreciable population of holes in the semiconductor adjacent to the metal. There is a change from N-type conduction in the bulk to P-type in the "inversion layer." In this case, in the direction of easy flow, the current may consist predominantly of electrons going from the valence band rather than the conduction band, leaving holes in the valence band. These flow into the bulk of the semiconductor increasing the conductivity. It is the discovery of this effect that led to the first point-contact and junction transistors, but as we shall see the discovery came about in a roundabout way. Mott and Schottky considered the flow of only one type of carrier.

In our review of background material, we became acquainted with the large amount of work that had been done during the war on silicon and germanium as "cat's whisker" detectors for radar. An extensive study of these elemental semiconductors had been carried out at university, government and industrial laboratories. The study of silicon was initiated by Russell Ohl at Bell Laboratories just before the war and was carried further at the Radiation Laboratory at MIT, the University of Pennsylvania, Bell Labs, and elsewhere. The study of germanium was initiated by Karl Lark-Holovitz at Purdue. By 1946 it was possible to produce relatively pure polycrystalline ingots of silicon and germanium and to control their electrical properties by introduction of appropriate donor and acceptor impurities.

Because of this background, we decided to concentrate our research efforts on germanium and silicon. An important advantage of these materials is that they can be made either N- or P- type, depending on the nature of the impurities introduced. This is not true of many semiconductors. Another is that, being elements, they are easier to purify.

Not long after I arrived at Bell, Shockley asked me to check some calculations he had made earlier in the year (1945) on the possibility of making what is now known as a thin film "filed effect" transistor. A semiconductor in the form of a thin film forms one plate of a parallel plate condenser. Shockley suggested that one could control the conductance of the film by a transverse electric field from a voltage applied across the condenser. With reasonable dimensions, the induced charge on the film should be comparable to the total charge of the carriers normally present in the semiconductor. Thus if the induced charge consists of mobile carriers, one should be able to make substantial changes in the conductance. With suitable geometry and materials, the effect should be large enough to produce amplification of an a.c. signal.

Various attempts to observe the effect all failed. This suggested to me that the induced charges were trapped in surface states for electrons at the surface of the film and thus were not available for conduction. I found that only a small concentration of surface states, less than one per hundred surface atoms, would be sufficient to effectively shield the interior of the film from the applied field. If there were surface states, other consequences should be observable; a Schottky space-charge layer should exist at the free surface, with the charge in the layer compensated by a charge in the surface states. It is possible to have an inversion layer of opposite conductivity type on a free surface. If the barrier is determined by surface states, rectification characteristics should be independent of the metal used for the contact.

It was decided to initiate a basic research program on both bulk and surface properties, with Pearson primarily responsible for bulk and Brattain for surface properties. Experiments carried out by Brattain helped to verify the surface states hypothesis. One may get information about the surface barrier from the contact potential and the way it changes with illumination of the surface. Brattain and Gibney found that the surface barrier could be altered if the voltage is applied through an electrolyte adjacent to the surface. Evidently, ions piling up at the surface gave a field sufficiently large to penetrate the surface states. This meant, in principle, that with suitable geometry one should be able to change the number of free carriers by an applied field and thus make a field-effect amplifier.

Experiments carried out with Pearson showed that the mobilities of the carriers in the thin evaporated films used to try to observe the field effect were very small compared with those in good bulk materials, so that the change in conductance of the film from a transverse electric field would be small even if surface states were not present. To get the effect of a thin film in bulk material, I suggested that one use an inversion layer on the surface. It was known that with proper surface treatment one could get a thin inversion layer of N-type conductivity of a few hundred Angstroms thick on the surface of a block of P-type silicon. In order to contact the inversion layer I suggested using a cat's whisker contact.

In discussions with Brattain, we decided to try the arrangement illustrated in Fig. 4. A small drop of electrolyte surrounded, but was insulated from, a metal point contact which made a rectifying contact with the P-type block. When biased in the reverse direction, metal positive, the current consists of holes flowing from the interface to the interior or of electrons flowing in the inversion layer to the contact. By applying a field through a voltage applied to a wire in contact with the electrolyte, we hoped to be able to change the concentration of electrons in the inversion layer and thus the reverse current. A negative voltage should decrease the concentration of electrons and thus the current and a positive voltage should increase it. The experiment was successful the first time it was tried. This was the first solid state amplifier and it demonstrated that the field effect principle is a valid one.

Brattain and I next decided to try the experiment with N-type germanium, which was known to make a good rectifying contact to a metal point contact. Although we had no prior knowledge that a P-type inversion layer might be present on the surface, the experiment was successful. In this case a negative voltage applied to the electrolyte increased the reverse current and a positive voltage caused a decrease, as expected from the field effect.

Because of the slow response time of the electrolyte, amplification occurred only at very low frequencies. In order to eliminate the electrolyte, we attempted to grow a thin oxide film on germanium and evaporate a gold electrode on the surface. The idea was to test the field-effect principle by placing a point contact in close proximity. The principle is that of present day MOS (metal-oxide-semiconductor) transistors.

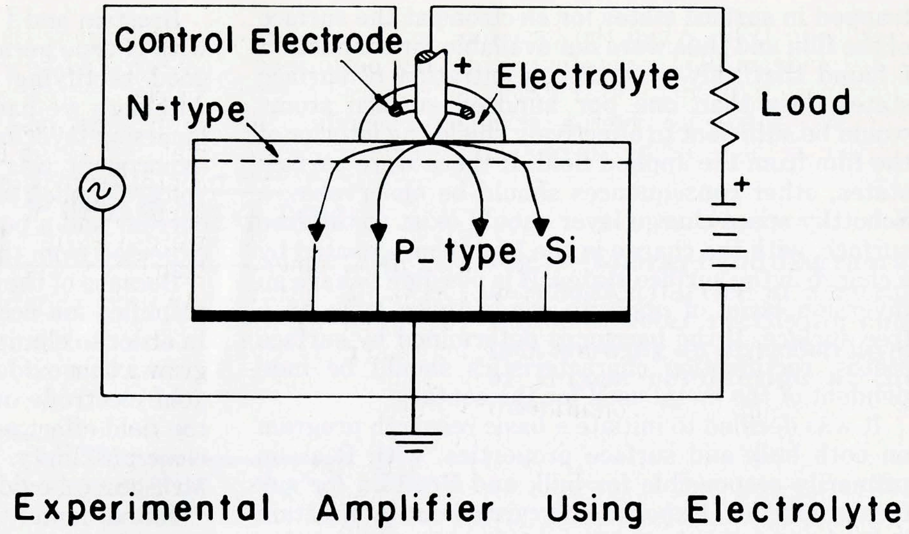
It was found that the gold spot was not insulated from the surface but made ohmic contact with the germanium. We decided to see what would happen anyway. Brattain placed the point contact biased in the reverse direction in close proximity to the spot and applied a small voltage between the gold electrode and a large-area low-resistance contact on the base of the block of germanium. It was found that the current from the gold electrode had a large effect on the reverse current to the point contact, but that the effect was in a direction opposite to that expected for the field effect; a positive voltage on the gold electrode increased rather than decreased the current flowing to the point contact biased negatively. We concluded that holes must be flowing from the gold contact. There was some voltage but no power amplification. This was the first indication of the transistor effect, a change in conductance from current flow from an appropriate contact.

The geometry used is not one expected to be very efficient for transfer of holes. Brattain and I next decided to try two parallel line contacts placed very close together. A gold foil was wrapped around a plastic wedge and the foil was slit where it passed around the knife edge. As shown in Fig. 5, a spring was used to press the wedge on the germanium surface, and connections were made to the foil on each side of the wedge. On contact, the hole emitter was biased in the forward direction (positive) and the other, the collector, in the reverse (negative). The experiment worked the first time it was tried; there was both voltage and current amplification of an input signal, with an overall power gain of about 20 db. The point-contact transistor was born.

It was soon realized that parallel contacts were not necessary. If the reverse resistance was not too high, the field of the collector current should draw in holes from the surrounding region of the germanium crystal. We then changed the design to two point contacts placed close together. A signal applied between the emitter and the base electrode appeared in amplified form across a high-resistance load between the collector and base.

The point-contact transistor was demonstrated to top executives of the Bell Labs on December 23,

Fig. 4—Experimental field effect amplifier with a drop of electrolyte surrounding but insulated from a metal point contact.



1947, and this day is taken as the date of the invention, although the first experiments were carried out a week earlier. The discovery created great excitement. A group was set up under Jack Morton to develop the point-contact transistor into a practical device. In the first model, called type A, the device was packaged into a small can about as big as the eraser on the end of a pencil. Most of the structure was to hold the point contacts in place. The active region in the germanium adjacent to the contacts had a dimension of the order of tens of μm, not much larger than present-day transistors.

The first public announcements and publications were made in June, 1948, after patent applications had been filed worldwide. At a press conference in New York City, there were demonstrations of the transistor as an amplifier and oscillator as well as in a radio receiver without vacuum tubes. Devices at that time operated to about 15 Mc. The lay press paid little attention, but there was a great stir in the technical press.

The Junction Transistor

At first it was uncertain how the holes introduced at the emitter contact flowed to the collector. Did they flow in the inversion layer or through the bulk with their space charge compensated by a corresponding increase in electron concentration? In an attempt to understand the mechanism, Shockley devised another configuration, the junction transistor, in which the entire process occurs in the bulk of the semiconductor. He suggested replacing their point contacts with PN junctions.

A PN junction is a boundary between two regions of a semiconductor which differ only in the nature of the impurities present. In the P-region, the impurities are acceptors and conduction is by holes. In the N-region, impurities are donors and conduction is by electrons in the conduction band. The impurities may be present in concentrations as small parts per million or less.

A PN junction is rectifying when the direction of easy flow is that with the P-side positive with respect to the N-side. Holes flow from the P-side to the N-side and conduction electrons from the N-side to the P-side, increasing the conductivity. In the reverse direction, electrons would have to flow from the P-side to the N-side or holes from the N-side to the P-side. But there are very few electrons on the P-side and very few holes on the N-side, so the current is small.

In an NPN junction transistor, a narrow region of P-type conductivity separates two N-type regions, with low-resistance contacts made to each region. One junction, biased in the forward direction, acts as the emitter and the second, biased in the reverse direction, as the collector. Electrons injected into the P-type base layer diffuse to the collector and contribute to the collector current rather than flowing to the base contact. Thus a voltage applied between the base and emitter serves to control the current flow between emitter and collector.

Shockley got the idea for the junction transistor within a month or so after the invention of the point-contact transistor, but kept the idea to himself while he was working out the details. In the meantime, John Shive tried making a transistor with point contacts on opposite faces of a thin wedge of germanium. He found that it operated in a similar manner to one with both contacts on the same side. He described his results to the group in a seminar talk on February 22, about a month after Shockley had described the junction transistor concept in his notebook. It was obvious from Shive's talk that the holes were flowing through the bulk. Shockley then disclosed his ideas concerning the junction transistor.

At first Shockley thought his design might be useful for a high-power transistor. It was only later that it was realized that the junction transistor had excellent characteristics in its own right. He later worked out the theory in detail and published the results in 1949. When the first junction transistors were made, in 1950, it was found that they performed very close to predictions. Fabrication required great advances in semiconductor technology, including in particular the growth of high-quality single crystals.

Early Developments

For two or three years the major development effort in Jack Morton's group was on point-contact transistors. Shockley's group was concerned mainly in developing a better scientific understanding of the flow of electrons and holes in semiconductors under the nonequilibrium conditions that prevail under carrier injection. In retrospect, there was a large gap between the scientific and development efforts in that no one was responsible for the development of semiconductor technology independent of any particular device.

The point-contact design was arrived at because the experiments were very easy to do within the limits of known technology. Since there was a built-in positive feedback in the device, the characteristics were far from the optimum described in a triode. It was difficult to design to a set of prescribed characteristics; there was insufficient flexibility in design. Initially, reproducibility and reliability were poor. Point-contact transistors had some very limited applications in the telephone system, but had no widespread use. The year 1952 marked the turning point to junction transistors.

Transistor development might have taken quite a different course if the need for the development of semiconductor technology had been recognized earlier. Gordon Teal, who wanted to grow crystals, could find no support in the beginning and finally had to bootleg this project. Shockley thought that he could cut what small crystals he would need for polycrystalline ingots and gave Teal no more moral support. The metallurgists thought they could produce as good a material as desired with the ingots. After the first single crystals were grown, Morton supported the project because he felt that use of single crystal material would improve the reproducibility of point-contact transistors. After they became available and their excellent qualities recognized, single crystals were used in all scientific work. The first junction transistors were made by doping the crystal appropriately as it was being grown by pulling from a melt.

The technology of growing single crystals of germanium, silicon and other semiconductors had developed continuously over the years. With increasing crystal perfection and purity, the mobility of the electrons and holes increased linearly and with time for some years, leveling off to values characteristic of the ideal crystal around 1954. The size of the crystals has also shown a steady increase from dimensions of a few centimeters in the early days to the present state-of-the-art crystal.

Recognizing that transistors would have broad applications far beyond the telephone system, Bell adopted a policy that made it easy to obtain licenses which gave access not only to the patents but also to the underlying technology. A large number of companies in this country and abroad did obtain licenses and many initiated or expanded their research programs on semiconductors. This infusion of ideas and approaches from many different sources did a great deal to stimulate the rapid growth of the technology. While many of the key advances came from Bell, many came from other organizations. For example, the first alloy junction and diffused junction transistors were made at General Electric by R. N. Hall and co-workers. The first alloy junctions to single crystal silicon were made by Pearson at Bell, but the first commercial silicon junction transistors were made by Teal and co-workers at Texas Instruments.

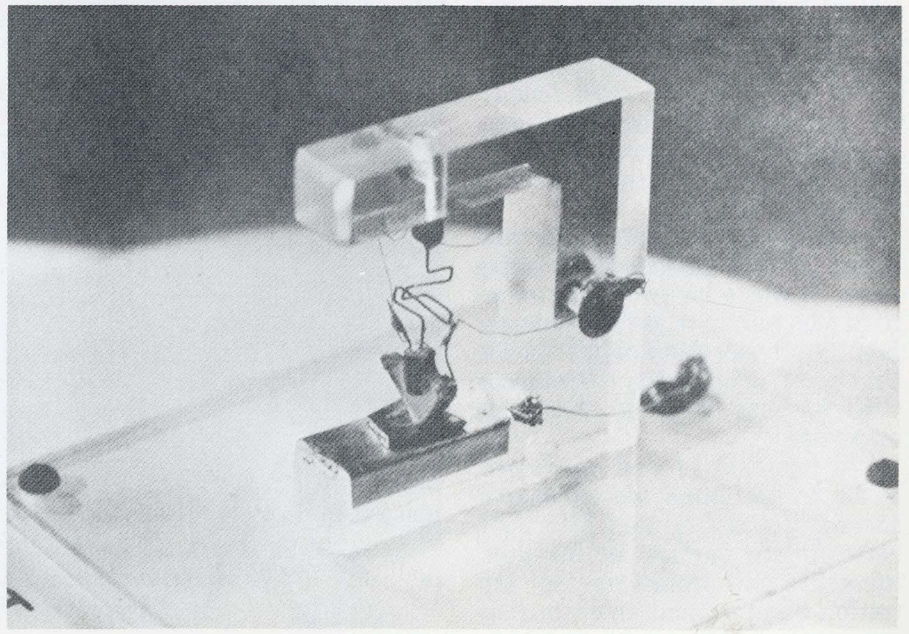


Fig. 5—Laboratory demonstration model of the first bipolar transistor.

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The chapter has its sights on two future projects. First, a job fair will be held in the Engineering Building. The idea is to help the younger engineering students find summer and co-op jobs. Second, plans are being made for Engineer's Week in February. As in the past, Eta Kappa Nu will create a departmental display and have a bake sale. Many members will be actively participating in these events with hopes of benefitting the entire engineering student body. *by Stephen Schaefer*

EPSILON IOTA CHAPTER, San Jose State University — During the spring semester our chapter pursued the fall project of collecting tests from professors for our student test file. We also continued to hold the student-faculty meetings at which we discussed ways to improve the EE curriculum. However, the most beneficial aspect of these discussions was in the communication leading to better understanding between students and faculty.

A highlight of the semester was a day at the Golden Gate horse races. It was a lucky day for members who participated because our faculty advisor (and expert in the theory of probability) Professor O'Flynn was there to share his expertise.

We initiated 11 new members. Prior to initiation we sponsored several get acquainted afternoon refreshment parties for initiates, members and professors. Our initiation banquet had an enthusiastic attendance of old members and faculty to welcome the new members.

THETA PSI, University of Nevada-Reno — The students of the Theta Psi Chapter at the University of Nevada-Reno experienced a fun year of increased activities in this the second year of our existence as a recognized chapter.

One of our first activities was the compilation and distribution of a Resume booklet. 25 EE Seniors took part, and the books were distributed to over 90 EE firms locally and nationwide.

In the spring 12 of our members visited and toured two local firms. Our first stop was at Hytek Microsystems, Inc. of Carson City, NV, a designer and manufacturer of hybrid circuits. The manager there is Charles Higginbotham (back row, center of the enclosed picture). Charles is a UNR EE alumnus, and was initiated into the Theta Psi Chapter this past March.

29 new members were initiated at our Annual Spring Initiation Banquet, held on March 30 at the Liberty Belle Restaurant in Reno. The highlight of the evening was when Secretary Teresa Nauman was named "Most Outstanding Pregnant Member." Teresa gave birth to a baby boy, Alex, in March. *by David Heppe*

University of Nevada—Reno