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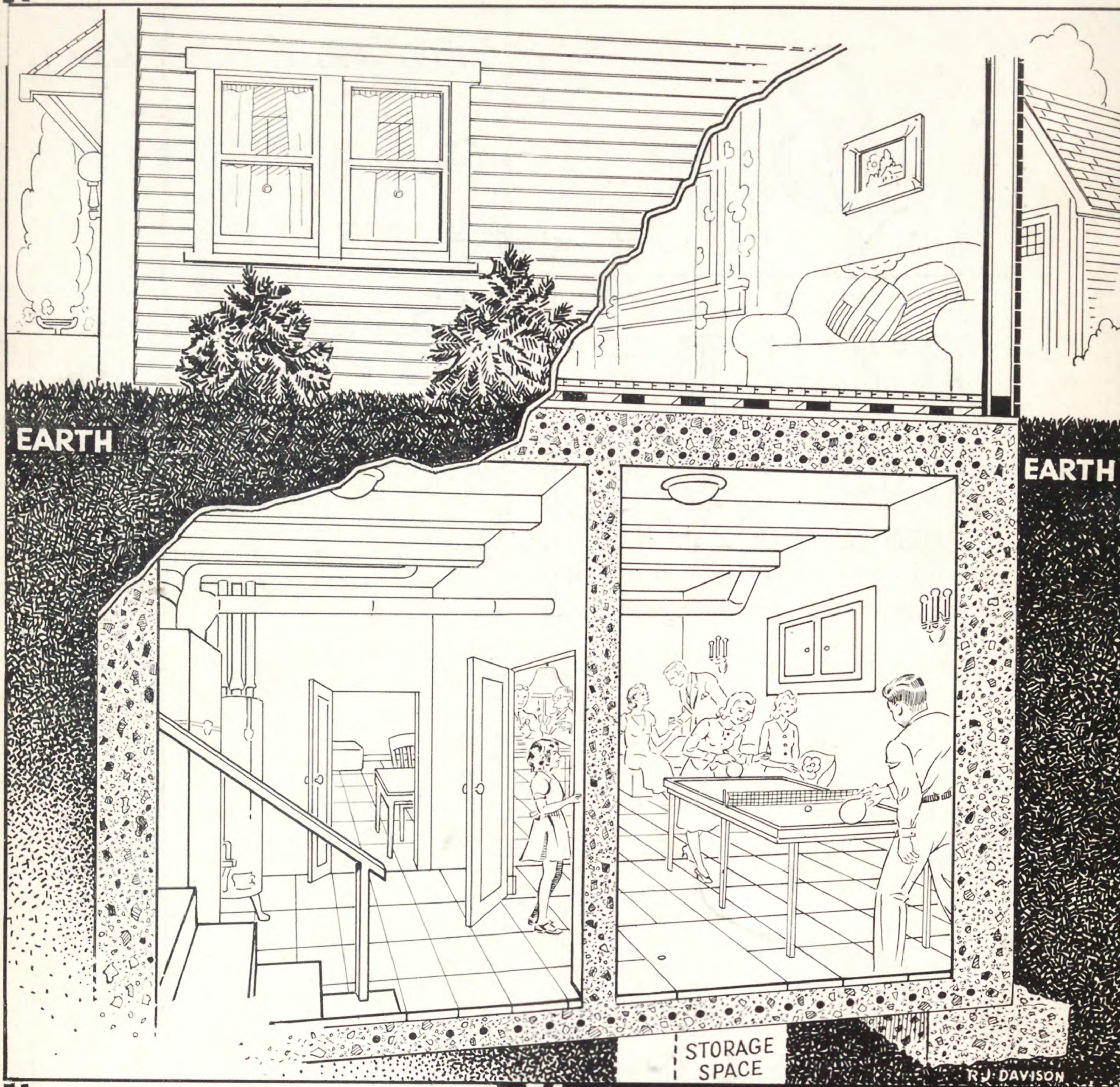

The BOMPUS-RUMPUS ROOMS

Proposed combination of recreation rooms and bomb shelter for small American Homes.

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(WHERE BOMBS CAUSE NO RUMPUS)

NEWARK ENGINEERING NOTES •

VOLUME IV NUMBER 1
NOVEMBER, 1940

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THE PRESIDENT'S DIARY

October 15

Last night I had the pleasure of speaking before the Civil Engineering Student Branch, that is, the Student Branch of the American Society of Civil Engineers, and I chose for the subject, "The Civil Engineer's Place in National Defense."

There was an excellent turn-out and for my part it was a very enjoyable evening, and I think that perhaps a little thought was stimulated along the line of the civilian's very important place in any total war.

Specifically, the point that I tried to make was that in a war where the civilian population was subject to great suffering the protection of the civilian population was a very important part of the whole defense program and, further, that this defense of the civilian population was to a very considerable extent the responsibility of the civil engineer.

I feel very strongly that while the civilian population, as such, is not a positive force toward the winning of the war, it may become a very important factor in a somewhat negative sense. If, for instance, our whole Metropolitan Section were open to attack from the air and we were required to defend it, the civilian population, its care and its disposal, might be the determining factor in the effectiveness of our defense. Certain things indicate that it was in Holland and Belgium, and the taking care of the civilian population in England is certainly a problem of major difficulty. For this population must not only be housed and sheltered, clothed and fed, but they must be kept healthy and happy as well. This involves proper housing and shelter against aerial bombardment.

This means that not only must they be protected from bombardment but there must be proper feeding within the shelters, there must be proper air conditioning in order to sustain health, there must be proper water supply, proper sewage disposal. In fact, all those things that are so important in our civil subjects—sanitary science and public health—must be taken care of. There must be, too, hot food, there must be hospital and recreation facilities—in fact there must be everything which makes life bearable if the civilian population is to be conserved.

It means keeping open highway and railway communication in order to properly feed; it means, in fact, something which would approach almost a re-design of railway, highway and marine terminals. It means decentralization; it means dispersion; it means ironing out vital spots and substituting for them certain alternatives which are not susceptible to annihilation by one crashing explosion. It may mean the necessity of evacuating whole cities and towns, dispersing their inhabitants, so that no real target is offered.

It may even mean forced evacuation quickly and definitely of small areas where the concentration of population is especially high. It may mean, in a word, a series of alternates, a series of links, a series of by-passes. It certainly does mean that the civil engineer in national defense could properly turn his mind toward some of these questions as very profitable lines of conjecture.

I think I succeeded at least in focusing the attention of these young men, soon to become civil engineers, on some of the problems which the future might hold, on the theory that it is better to do this while they are yet young than to wait too long.

I remember once I had the responsibility for inviting some eminent gentlemen to a banquet, and I woke in the middle of the night—the night before—to realize that I had left out one of the most important men who should have been a guest. Time and time alone sometimes has a way of stepping in and making impossible things that must be done.

November 15

Since my talk before the Civil Engineering Society it has been very heartening to see our civil engineers really considering problems of this kind. Not only in our small way locally but from my contacts it is becoming evident that we are getting just a little bit more sensitive—and sensitive in the right sort of way—without fear and without panic concerning this general situation.

I even hear of courses being offered, of societies of engineers considering things along this line. I hope that we may continue thinking about it. I hope that we think about it calmly, philosophically and professionally. Above all, I hope that by thinking about it we destroy even the remotest possibility of having to *do* it.

Allan R. Cullimore

November 27, 1940

DEFENSE SHELTERS FOR CIVILIANS

By Harold N. Cummings, A.B., S.B.

Professor in Civil Engineering, Newark College of Engineering

National "Defense," as discussed by President Allan A. Cullimore of Newark College of Engineering, means protection of the civil population and of civil facilities. A defense army, navy, and air force cannot do much defending without the continuous functioning of civilians in activities "behind the lines." This means that we must protect not only the lives of the people but also, so far as possible, their property, both personal and public. The primary defense is, of course, the duty of our armed forces. They will meet and attempt to turn back or destroy the enemy before he can get into or over the country. However, small and even large groups of highly destructive enemy air-units can and surely will get through any armed defense system, and unload tons of high explosives, frequently destroying "non-military objectives" such as homes, public buildings, churches, schools, etc., as well as industrial or transportation facilities.

What defense can we offer against these air-raiders who have broken through the marginal armed defense lines? Armed Home Guard Units will be absolutely useless against any enemy that stays more than a few hundred feet above the ground and who travels at a speed of more than a few miles an hour. The enemy will distribute his explosive and incendiary bombs and his machine gun bullets with impunity. Against this kind of attack the civilian can do nothing but run for cover, *if there is any cover available.*

In other words, AIR RAID SHELTERS must be provided for all people in areas liable to air attack.

The design of shelters is definitely a big engineering problem, calling for several solutions, each adapted to a particular condition. The sheet iron igloo, at mail-order prices, is not the general nor perhaps even a particular solution. To the writer there seem to be two quite different classes of shelter problems, the one being for occupants of existing structures and the other for those who will occupy structures still to be built. Just what are the best designs for either of these cases is not immediately apparent. Best designs are obtained only after careful analyses of all phases of the problem, and it is the purpose of this article only to indicate some of the things that should be investigated before settling down to the structural features of the designs.

First, perhaps, we should determine what areas are liable to air attack here in the United States. And, among such areas, which ones are most liable to attack and therefore in need of protection first. Then, what kinds of structures in all these areas are liable to be occupied by people, and how many people are likely to be caught in each type of structure, and how many in each building in each type. Can the buildings be evacuated quickly? If so, where and how can the occupants be assembled for protection? Problems of planning, management, begin to appear in the picture, particularly in handling crowds during raids. How much time is available for getting people into shelters? The answer to this question certainly is needed before deciding how far apart shelters can be built. Are there any buildings that already provide protection? What sort of forces must be designed against, that is, direct hits, or only the result of a building collapse? The experience of the British certainly should be studied, for there we have full scale "laboratory" tests covering a wide range of conditions. Does steel or concrete afford the best protection? How about timber? Etc., etc., etc. Certainly a tremendous list of questions will arise when the engineering profession gets around to work on the problems of air raid shelters.

Many different plans will suggest themselves for the shelters. In some cases, reinforcing certain floors to stand the shock of total collapse of the building above might be at least an emergency soution. In others, evacuation to the basement of a nearby building might work, if that basement were properly prepared.

Proper preparation suggests not only structural design but sanitation arrangements. How extensive need these be? That depends upon the number of people to be accommodated and the probable duration of raids in a given area. Sanitation suggests not only toilet facilities but also ventilation and heat in cold weather. The list of things to be considered is long, and so far we have considered only the problems arising in congested areas. How about residential areas in dangerous locations? Should each one or two family house have its own shelter, or should there be community shelters, such, for example, as one in each block? In either case, sanitation should be considered. What types of protection are best for dwellings? The answer is not simple. It depends upon many things such as building types, presence or absence of basements, types of neighboring buildings that might topple over and increase the impact load, etc.

In the matter of buildings still to be built, the problem of providing shelters is interlocked with the problem of "dispersion" of the buildings themselves. Plant design and community planning enter the picture here. Obviously it is easier and less expensive to include a room or a basement compartment with extra strong ceiling and walls, with adequate toilet, light, heat, and ventilation equipment, in the design of a new building than it is to provide the same facilities by remodeling existing buildings. Rigid control to prevent crowding houses together and to prevent building easily shattered structures may be necessary.

One engineer has suggested to the writer an inexpensive arrangement of the modern recreation room in the basement of a dwelling to allow for protection when needed, and for the normal activities of the occupants at other times. He estimates an added cost of about $400 to the cost of a dwelling to cover this new feature.

In the matter of both existing and new buildings, a "Shelter Kit" might be provided to give the occupants some means for carrying on during incarceration in shelters under demolished buildings. Such a kit would have, perhaps, candles, simple first-aid outfits, some sort of fabric buckets and necessary chemicals for emergency toilets, short-handled axe, spade, and pick, concentrated foods, "canned heat" stoves, etc., chemicals for sterilizing drinking water, fire extinguisher, gas-masks perhaps, etc., etc. These kits could be assembled by mass-production methods, and sold—or issued by the authorities—to the people living in danger zones.

Who should pay the cost of this branch of our defense program? Again the answer is not simple. Who will benefit? Does the general public benefit by the saving of lives in industrial regions? If so, what proportion of the cost will fairly represent the general public interest?

Who should administer the work of providing protection for the civilian population? Should there be a federal or a state administration of the work? Should the administration be in hands of engineers, business men, politicians, or whom else?

Any one that has read through this article to this point may have a feeling of confusion, an idea that the problem is complicated beyond the possibility of solution. However, it *must* be solved, and therefore it can be solved. Time may be of the essence, and if so a set of partial solutions may be all that can be obtained at present.

But if total defense is to be total, it must provide for what

(Continued on page 21)

HIGHWAYS AND DEFENSE

By ROBERT W. VAN HOUTEN, B.S., C.E.

Assistant Professor in Civil Engineering, Newark College of Engineering

The President's Diary in this issue of the NEWARK ENGINEERING NOTES is devoted to the subject of National Defense. In it President Cullimore points out that there are many problems with which to deal, not the least of which is that of providing for the uninterrupted flow of traffic under all conditions. The unimpeded movement of the Army's mechanized forces, so vital in the successful defense of the nation, is of primary importance. Adequate means must be provided for the mobility of these units, but also it is essential that the civilian population be provided with an adequate supply of food, fuel, clothing, etc. The civilian population, which in the war of today suffers the brunt of the attack, must be kept from starving and freezing if their morale is to be kept at the high level so necessary to successfully resist a would-be invader.

The War Department and the Bureau of Public Roads for some considerable time have been studying the problem of selecting adequate routes for the movement of the Army's mechanized units. The problem which faces us in this nation is entirely different from that of a smaller country which is offensively inclined and, therefore, can select the points of attack against its neighbors. Such a country can build its super highways and use them when prosecuting the attack. Our country is primarily interested in the problem of defense and we can only attempt to predict where the scenes of action may be. Hence, the roads of the entire country were studied, particularly with reference to those areas which the War Department believes would be attacked first. Tremendous progress has been made. Maps have been prepared on which certain roads have been designated as being of primary importance, others of secondary importance and still others of tertiary importance. It is not to be inferred from the foregoing statement that the design and construction of the roads of tertiary importance should be inferior to those of primary importance. The distinction is based upon the estimated relative military importance of the respective roads and a road of tertiary importance may, in a time of emergency, be called upon to carry as heavy loads and as great a concentration of traffic as one originally designated as being of primary importance.

The demands placed upon a road during military operations are much greater than during times of peace. Therefore, the War Department has recommended certain standards of design and construction which, if followed, would provide roads adequate for military purposes. These specifications include: the types of approved surfaces, wheel loads to be expected, width of roads and bridges, anticipated loadings on bridges, maximum grades and degrees of curvature for all kinds of terrain, and also vertical clearances and sight distances. Obviously our existing highways do not meet all, or in some cases any, of these standards, but it will be possible to remedy the weak links in our chain of highways to meet the requirements of the War Department. The recommended standards of design and construction should be adhered to for all new roads. Obviously the purely military aspects of the transportation problem are well in hand.

The situation with respect to civilian transportation over our highways is not nearly so bright. Much thought needs to be given to the question of selecting adequate routes to and from our metropolitan areas to provide for the uninterrupted flow of the necessities of life. The seriousness of the problem is readily apparent when one considers the congestion caused on even a three- or four-lane highway by the breakdown of one car in times of heavy or even normal traffic flow. Traffic is generally slowed to a snail's pace if not completely stopped. It is not difficult, then, to imagine what would result if only one lane of an important highway were rendered impassable by a well-placed bomb. What an ideal target a lane of stalled or creeping cars and trucks would make for an enemy bombing squadron. Not only would there be considerable loss of life and supplies under such conditions, but the unplanned re-routing of this traffic might seriously interfere with the mobility of our mechanized forces.

A solution to this problem can be worked out, but it will require intensive investigation and study and careful planning. It matters not what agency or organization assumes responsibility for the solution of this problem, so long as it is placed in competent hands and full authority for dealing with the problem is given by the proper authorities. The solution should not be arrived at under the stress of extreme emergency. Chaos can and will result from such lack of foresight.

One step toward the solution of the problem might include a survey of the sources of the bulk of the foodstuffs, fuel, and clothing coming into the metropolitan areas over our highways, together with a determination of the routes normally used. Close coöperation with the War Department would be necessary so that on a moment's notice civilian traffic could be re-routed to avoid conflict with the defense forces rushing over their pre-selected routes. Because of the use of the normally traveled routes by the mechanized forces for some considerable time or because of extensive damage to the roads, plans should be available for the immediate re-routing of civilian traffic. This, of course, presupposes complete surveys of all possible highways, not only as to terminal facilities, but also with respect to the load capacity and widths of roads and bridges, maximum grades and degrees of curvature, etc. A study should also be made to determine the minimum requirements of the civilian population in each metropolitan area in the event that railroads or the waterways were rendered impassable and all supplies had, of necessity, to be carried over the highways.

Another aid to the effectual movement of traffic would be a system of detours around designated sections of each highway. This would mean that, if one section of a highway were rendered impassable, traffic immediately could be detoured around it. Home Guard Units would be invaluable in keeping traffic moving under such a plan. For example: If section A of route 22 was rendered impassable, the members of the Home Guard would immediately report to their assigned posts to direct traffic around the damaged section and over the pre-selected detours with a minimum of confusion and loss of time. The Home Guard Units would have to be an integral part of the transportation organization and dress rehearsals would, of necessity, be required so that in an emergency the plan would go into operation without any delay.

In connection with a dress rehearsal, it would be possible to suddenly notify a Home Guard Unit that section C of route 29, for example, had been damaged, and that traffic must be detoured around it. The members of the Home Guard would then rush to their stations and actually direct over the detour certain cars that were traveling with traffic but that were a definite part of the dress rehearsal. These cars could be designated by flags or some other insignia. A program for the re-routing of traffic cannot be put into practice without not only adequate study and planning, but continuous practice as well.

Finally, we should give some considerable thought to the

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BOMB SHELTERS AS RECREATION ROOMS

By ODD ALBERT, B.S., C.E., M.S.

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The newspapers of this nation during the last few months have published vivid accounts of the damage inflicted by air attacks on European cities. Americans have become deeply interested in the methods that governments on the other side of the ocean have devised to safeguard the lives of men, women, and children during air raids. The most effective way thus far found for civilians to escape injury or death is by means of bomb-proof shelters.

Certain disadvantages in this type of protection have already been found, although their success as a safety measure is generally admitted. The complete story of these shelters has not reached us yet, but we have received enough information in this country for us to realize that the people assembled in the shelters do not enjoy much comfort during their enforced stay. Real rest is very difficult, and any considerable amount of sleep is practically impossible. The strain on the physical and emotional system of the individual is very severe. Contagious diseases have a fertile field for development, while ordinary illnesses, such as colds, influenza, etc., may easily become epidemic with such large numbers of people confined in a limited space for many hours. Such shelters, too, have the disadvantage by their very size in having made it necessary for inhabitants in many instances to travel a considerable distance to their protecting walls. In addition, where anything does go wrong in large shelters, injuries and deaths are proportionately higher because of the numbers of individuals inside.

Therefore, we ought to think about the future and the problem of enemy air raids over our towns and cities. New construction is going forward constantly in the United States. It is, therefore, suggested to provide bomb-proof shelters in each new building from this time forward. That is, when one or two family homes are being built, when apartment houses, office buildings, stores, factories, etc., are being planned, such plans should provide for bomb shelters in each construction.

For such purpose, the cellar could be utilized to the full area covered by the building, as can be seen in the sketch. The ceiling of the shelter could be reinforced concrete, twelve inches thick, with beams of the same material, twelve inches wide and twenty-four inches deep, spaced about eight feet apart on centers. The support would be by reinforced concrete columns or reinforced concrete walls. This cellar can be equipped as an ordinary recreation room with possibilities of making a living in it for a long period possible and enjoyable. For such purpose, the bomb-proof cellar might be divided in three parts, where in general one part will be designed for living, one part for sleeping, and the third part will serve as the utility room. It will easily be seen that the first and third part of the proposed bomb-proof cellar will function permanently.

Such construction would be, of course, fireproof, and able to carry a load of over 1,000 pounds per square foot as compared with a required design load of 60 pounds per square foot, which is the strength of present-day floors. Therefore, even if a building with a bomb cellar is wrecked or burned down to the ground, the cellar will be intact, as the ceiling construction is strong enough to carry the load of debris of a caved-in building three or four stories high, so that it will still be possible for the occupants to continue to live in their bomb-proof shelter, and thus eliminate one of the great tragedies of present-day warfare—homeless people. There are other advantages with a village of houses with bomb-proof cellars. If every house should be leveled to the ground, the people could still continue to live in their cellars, and if the people leave their village the cellars can be used for many military purposes, as, for instance, for housing soldiers, for hospitals, for storehouses for supplies and ammunition, etc.

Some objection may possibly be raised because of the increased cost of the construction, but the cost is generally not as high as one would think on first consideration. With our American genius for mass production and the standardization of steel forms and materials of construction, the cost should not be excessive in view of the permanence and the potential utility of the construction. For instance, in a home costing $10,000 one estimate places the cost of constructing a cellar bomb-proof shelter at $400 additional. The increased cost should be offset by advantages given the owner. For instance, if a special low-interest rate be charged on loans for houses with bomb cellars, it might be possible that the monthly charges will not be more than for an ordinary house.

While the primary reason for such constructions would be their availability for use during war time, no one will deny the fact that there are distinct advantages to be gained by such constructions during peace time also. To mention just a few:

1. There is nothing to indicate to the eye that a building or home has a bomb-proof cellar, since over the reinforced concrete "roof" of the cellar the ordinary wooden or other type flooring would be laid.
2. The additional living apartments or recreation rooms obtained through this construction adds strength, permanence, and utility to the building.
3. The reinforced concrete construction gives an additional factor of safety, not only for the permanence and strength of the construction, but also for its fireproof materials.
4. In general, the whole building becomes a place of greater usefulness to the people working or living within.

THE COVER DESIGN

An artist's conception of suggested "Bompus-Rumpus Rooms" is shown on the cover. Attention is directed to the fact that the artist has not attempted to observe any engineering principles of design and construction, but merely to convey some idea of what a completed construction may look like.

Note the living quarters to the right, the sleeping quarters in the left rear, and a utility room in the left foreground.

The general appearance of the rooms seems to give an impression of security and comfort, and it seems reasonable to believe that even a rather prolonged stay in such quarters should not affect the health and morale of the inhabitants to any serious extent.

A PRECISION "Q" METER

By Alfred Heinz
Senior, Newark College of Engineering

Introduction

Within the last 20 years, numerous advances in coil design have been made, but the development of proper coil testing equipment has been sorely neglected with the result that, up to the present time, no really accurate "Q" meter has been developed. Manufacturers of radio equipment have therefore resorted to their own pet circuits and testing methods.

An investigation of the various circuits and testing methods most commonly used in measuring the "Q" value of coils brought out some rather interesting facts. It was found that the multitude of "Q"-testing methods could be classified under two fundamental groups, both of which employ the simple series-resonance circuit shown in figure one.

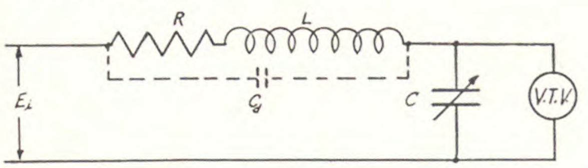

Figure 1

The first group is based upon the principle that the total reactance of a series circuit is equal to the effective resistance when the current flowing equals 70.7% of the current at resonance, and this fact is used to derive the formulae given below,

$$Q = \frac{X_L}{R_e} = \frac{f_r}{f_1 - f_2} = \frac{2C_r}{C_1 - C_2} \qquad (1)$$

where f_r and C_r are the respective frequencies and capacities at resonance, and f_1, f_2, C_1 and C_2 the respective frequencies and capacities at the two half-power points. The fact that the "Q" value of a coil is proportional to the voltage step-up ratio in a series circuit at resonance, is used in the second group. That is,

$$Q = \frac{X_L}{R_e} = \frac{E_L}{E_i} = \frac{E_C}{E_i} \qquad (2)$$

where E_i is the input voltage and E_L and E_C the voltage drops across the reactors.

At a casual glance both methods appear sound, but closer investigation reveals the fact that accuracy cannot be claimed as a factor of merit by either of them. For some obscure reason, the effect of the distributed capacity of the coil (C_d) was not considered. Therefore, the test results are indicative of an effective-"Q" value, which is of little significance, instead of the important absolute-"Q" value given in formula one.

In addition to this error in theory, there are also a few practical limitations. Thus, the frequency-variation method listed under group one is impractical for two reasons: Firstly, accurate frequency measurements are not easily made, and secondly, the input voltages must of necessity be kept constant over the range of frequency covered. Therefore, a costly precision oscillator is required. The objections to the second group are that accurate measurements of the small input voltages are difficult to make and that the input voltage as measured at the input terminals is in error due to the harmonic content of the signal.

Summing up the objections offered to the various "Q"-testing methods, we find that they are either inaccurate, impractical, or both. The need for an economical precision instrument is therefore quite acute, and the instrument whose description follows represents an attempt to eliminate some of the difficulties involved.

Description of Precision "Q" Meter

With due regard to the errors and limitations of the present "Q"-testing methods, it was decided to base the design upon a different principle, realizing that it, too, would have definite limitations. Thus, after considerable study of the possibilities of measuring the various circuit parameters conveniently, notably "Q," it was decided that an antiresonant circuit would offer the greatest possibilities. It was also found that greater accuracy could be obtained, that the measuring circuit had a degree of flexibility necessary for an all-around instrument, and, finally, that in case of coil measurements, the measuring circuit simulates actual circuit conditions. Difficulty in making the instrument direct reading in "Q" measurements was found to be the only serious disadvantage.

The circuit which was finally accepted is shown in block-diagram form in figure 2. Besides showing the electrical interconnections of the component parts of the instrument, the diagram also represents a front-view space diagram. It is to be noted that the wave meter is placed in the most advantageous position with regard to stray oscillator fields, thus eliminating pick-up difficulties.

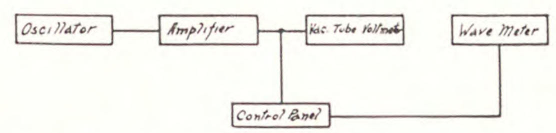

Figure 2—Block-Diagram of Precision "Q" Meter

Because the testing circuits for the various circuit parameters differ somewhat, relays are employed to perform the essential switching operations. These relays, controlled from a push-button panel, are placed into the most effective positions, thereby eliminating the disturbing effects of lead-capacity and -inductance.

The following is a brief discussion of the various circuit components. The power supply is electronically regulated to insure all-around stability. It is mounted on a separate chassis and can be removed with little difficulty. Connections to other units are made with plug-end cables.

The signal generator is an electron-coupled HARTLEY OSCILLATOR adjusted for maximum harmonic content. This may be contrary to popular practice, but harmonic content greatly simplifies the testing procedure for distributed coil capacity, while the accuracy of measurement for other circuit constants is unaffected by it. The oscillator is provided with four coils, mounted along with their trimmer condenser in a turret-type switch, giving ranges of 170-540 KC., 540-1700 KC., 1700-5400 KC., and 5400 KC.-17 MC. Due to this frequency-range arrangement, the dial of the oscillator tuning condenser requires but two scales, which arrangement eliminates the confusion resulting from multi-scale dials.

The amplifier is resistance coupled, adjusted for both low gain and maximum distortion, and provided with feedback arranged to give constant-current output for small changes of impedance.

The function of the amplifier is to act as a buffer to insure oscillator stability, to increase the harmonic content of the signal voltage, and to provide the means of obtaining constant line current in the wave-meter circuit.

The vacuum-tube voltmeter is a conventional bridge-type-peak voltmeter.

The control panel, equipped with eight push-buttons, serves the purpose of setting up the various testing circuits. Thus, the instrument can be put into any operation condition by merely actuating one of the push-buttons.

The wave-meter circuit is equipped with two variable-iron-core coils for measurements of capacity. These coils have a high "Q" value. There are two tuning condensers provided, which will be referred to, in the future, as the main- and auxiliary-condensers. The auxilliary condenser is of the 270° type, and its zero mark falls on its ninety-degree point. Both condensers are divided into two sections in the ratio of one to three. Relays located immediately above the condensers are so arranged that either full-, 25%-, or zero-capacity can be connected to the wave-meter circuits. The dials of both condensers are calibrated in terms of both 100% and 25% capacity, and the calibration of the main condenser includes the capacity of the auxiliary condenser with the latter set on zero. Ranges of tuning capacity available are 30-250 uuf. and 120-1000 uuf. An additional scale, calibrated in terms of (C_d), is provided for the auxilliary condenser.

Test Procedures and Derivations

In the succeeding paragraphs, test procedures for the various circuit parameters will be explained, and formulae expressing the relationship between the quantities being measured and other factors will be derived.

The circuit parameters which can be measured with the instrument are listed below.

I COILS
- A "Q" Value
- B Resistance
- C Inductance
- D Distributed Coil Capacity

II CONDENSERS
- A "Q" Value
- B Resistance
- C Capacity

III TWO-TERMINAL IMPEDANCES
- A "Q" Value
- B Resistance
- C Inductance
- D Capacity

Distributed Coil Capacity

Because (C_d) enters into the final equation for Q, it will be considered first. The method used is fundamentally identical with that described in Bulletin No. 74, Bureau of Standards, the modification consisting of the use of an antiresonant- instead of a series-resonant-circuit. The circuit used is that shown in figure 3.

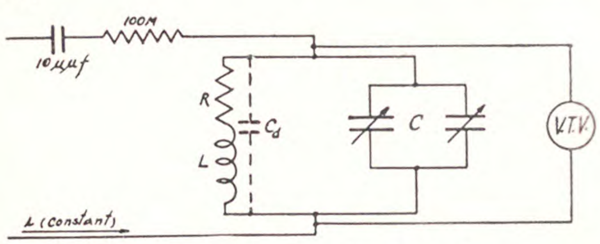

Figure 3—Antiresonance "Q" Meter Circuit

Now, if antiresonance is defined to occur at the point of maximum impedance rather than at the point of zero susceptance, then

$$X_L = X_C \quad \text{or} \quad L = \frac{1}{W^2C} \quad \text{and} \quad f_r = \frac{1}{2\pi\sqrt{LC}}$$

Applying this formula to a fundamental and its second harmonic, we get

$$f_1 = \frac{1}{2\pi\sqrt{LC_1}} \quad \text{and} \quad f_2 = \frac{1}{2\pi\sqrt{LC_2}}$$

The effective capacity, however, is the sum of the tuning capacity (C) and the distributed capacity of the coil (C_d). Therefore,

$$f_1 = \frac{1}{2\pi\sqrt{L(C_1+C_d)}} \quad \text{and} \quad f_2 = \frac{1}{2\pi\sqrt{L(C_2+C_d)}}$$

but $f_2 = 2f_1$,

so that $\frac{C_1 + C_d}{4} = C_2 + C_d$,

$$\text{and } C_d = \frac{C_1 - 4C_2}{3} \qquad (3)$$

This formula is identical with the one given in the Standard Bureau Bulletin quoted.

The actual test duplication is accomplished in a very unique manner, originated by C. Dennis. As pointed out before, the wave-meter line current is held constant so that antiresonance, as defined previously, is indicated by maximum voltmeter deflection. It is, of course, appreciated that due to the large harmonic content of the voltage, the harmonics also contribute to this voltmeter deflection. However, harmonics, as will be shown later, are sufficiently attenuated to be negligible.

Now, if the tank circuit, of which the coil to be measured forms an integral part, is first tuned to antiresonance at the fundamental frequency, and the tuning condenser is then reduced to 25% of its former capacity, accomplished by disconnecting the larger of the two sections of both main- and auxiliary-condenser, then the resulting tank circuit will be close to antiresonance at the second harmonic, and the deviation from this second antiresonance point will be proportional to (C_d). (C_2) in formula (3) is then related to (C_1) by the formula

$$C_2 = \frac{C_1}{4} - \Delta C_2 \qquad (4)$$

Substituting (4) into (3), we get

$$C_d = \frac{C_1 - 4\left[\frac{C_1}{4} - \Delta C_2\right]}{3} = \frac{4}{3}\Delta C_2 \qquad (5)$$

$$\text{But } \Delta C_2 = \frac{\Delta C_1}{4} \text{ (on the dial)}$$

$$\therefore C_d = \frac{\Delta C_1}{3} \qquad (6)$$

Formula (6) shows that direct readings can be had by an additional scale, calibrated to satisfy the above formula. The dial used is shown in figure (4) below.

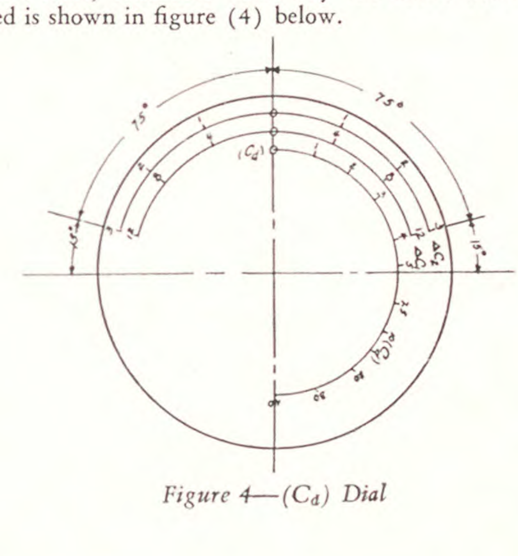

Figure 4—(C_d) Dial

The only possible error in this derivation is due to the effect of the harmonics upon the tuning-condenser voltage. This source of error will now be investigated. For the purposes of this investigation, then, let us assume that the "Q" of a coil is substantially constant for moderate frequency ranges, in this case from 50-200% of the specified frequency. This is a reasonable assumption; for measurements made with a large number of coils have shown this to be true. Then,

$$Q = \frac{WL}{R} = \frac{W_r L}{R_r}$$

where the subscript (r) denotes antiresonance. But if Q is constant, then the "R" at any frequency must bear a definite relationship to (R_r) which,

since $\frac{f}{f_r} = \frac{W}{W_r}$

can only be $\frac{f}{f_r} = \frac{R}{R_r}$ or $R = \frac{f R_r}{f_r}$ .... (7)

Letting $a = \frac{f}{f_r}$

formula (7) reduces to $R = aR_r$ .... (8)

By definition attenuation in db is expressed by the formula

$$db = 20 \log \frac{E_1}{E_2}$$

$$\text{or } db = 20 \log \frac{E}{E_r} = 20 \log \frac{e_z}{e_r} \qquad (9)$$

which, since the current is held constant, reduces to

$$db = 20 \log \frac{Z}{Z_r} = 10 \log \frac{Z^2}{Z_r^2}$$

$$\text{but } \frac{Z^2}{Z_r^2} = \frac{\dfrac{(R^2 + X_L^2)X_C^2}{R^2 + (X_L - X_C)^2}}{\dfrac{(R_r^2 + X_{Lr}^2)X_{Cr}^2}{R_r^2 + (X_{Lr} - X_{Cr})^2}} \qquad (10)$$

However, at antiresonance $X_{Lr} = X_{Cr}$, $X_L = aX_{Lr}$, $X_C = \frac{X_{Cr}}{a}$ and $R = aR_r$. Formula (10) then reduces to:

$$\frac{Z^2}{Z_r^2} = \frac{R_r^2}{R_r^2 a^2 + X_{Lr}^2 \left(a - \frac{1}{a}\right)^2} = \frac{1}{a^2\left[1 + Q^2\left(1 - \frac{1}{a^2}\right)^2\right]}$$

and formula (9) finally becomes:

$$db = 10\left[\log \frac{1}{a^2} - \log\left\{1 + Q^2\left(1 - \frac{1}{a^2}\right)^2\right\}\right] \qquad (11)$$

If the percent deviation from antiresonance (K) is represented by the formula:

$$K = \frac{f - f_r}{f_r} \times 100 \qquad (12)$$

then, for the second harmonic,

$$K = \frac{2 - 1}{1} \times 100 = 100\%$$

$$\text{and } a = \frac{f}{f_r} = \frac{2}{1} = 2$$

The attenuation of the second harmonic becomes:

$$db_{II} = -10 \log \frac{16 + 9Q^2}{4} \qquad (13)$$

When the circuit is resonated to the second harmonic,

$a = \frac{1}{2}$ and $K = 50\%$

and the attenuation of the fundamental becomes:

$$db_I = 10[\log 4 - \log(1 - Q^2\{1 - 4^2\})]$$

which reduces to:

$$db = -10 \log \frac{1 + 9Q^2}{4} \qquad (14)$$

Because the quantity $9Q^2$ is large compared with sixteen, formulae (13) and (14) will reduce to:

$$db_{I \text{ or } II} = -20 \log \frac{3}{2} Q \qquad (15)$$

Formula (15) clearly shows that the attenuation of the harmonics and subharmonics is sufficiently high to eliminate the possibility of an error from this source.

Coil "Q"

The succeeding paragraphs will be devoted to derive a formula for coil "Q" in terms of the capacity coefficients of an antiresonant circuit.

The circuit used is that shown in figure (3) and the symbols used in the derivation are:

e_r = the voltage across tuning condenser at resonance
e = the voltage across tuning condenser off resonance
i = the line current of tank circuit
R = the effective resistance of the coil
X_L = the effective reactance of the coil
X_C = the effective reactance of the condenser
X_r = the effective reactance of the condenser at resonance
X_1 = the effective reactance of the condenser above the resonant capacity
X_2 = the effective reactance of the condenser below the resonant capacity
$\triangle X_1 = X_R - X_1$
$\triangle X_2 = X_2 - X_R$

To start, the voltage across the tuning condenser will under all conditions be equal to

$$e = \frac{i(R + JX_L)X_C}{R \pm J(X_L \mp X_C)} \qquad (16)$$

but, since all three measurements are made at one definite frequency, X_L will always equal X_r

$$\text{and } i^2 = \frac{e^2[R^2 + (\pm X_r \mp X_C)^2]}{(R^2 + X_r^2)X_C^2}$$

At antiresonance, however, $X_C = -X_r$

$$\therefore i_r^2 = \frac{e_r^2 R^2}{(R^2 - X_r^2)X_r^2} \qquad (17)$$

and at any other point

$$i^2 = \frac{e_1^2[R^2 + (X_r - X_1)^2]}{(R^2 + X_r^2)X_1^2} = \frac{e_2^2[R^2 + (X_2 - X_r)^2]}{(R^2 + X_r^2)X_2^2} \qquad (18)$$

Because the line current is held constant,

$$\frac{e_r^2 R^2}{X_r^2} = \frac{e_1^2[R^2 + (X_r - X_1)^2]}{X_1^2} = \frac{e_2^2[R^2 + (X_2 - X_r)^2]}{X_2^2} \qquad (19)$$

If the two off-resonance readings are taken at voltages which satisfy equation:

$$e_r^2 = 2e_1^2 = 2e_2^2 \qquad (20)$$

$$\text{Then } R = (X_r \triangle X_1)\sqrt{\frac{1}{2X_1^2 - X_r^2}} = X_r \triangle X_2 \sqrt{\frac{1}{2X_2^2 - X_r^2}} \qquad (21)$$

At this time an assumption is made, introducing a small error which will later be corrected.

It is assumed that $X_r = X_1$ in one equation, and $X_r = X_2$ in the other.

$$\text{Then, } R_1 = \frac{X_r \triangle X_1}{X_1} \text{ and } R_2 = \frac{X_r \triangle X_2}{X_2} \quad (22)$$

and the corresponding "Q" values become:

$$Q_1 = \frac{X_1}{\triangle X_1} \text{ and } Q_2 = \frac{X_2}{\triangle X_2} \quad (23)$$

The two formulae (23) for Q are, of course, both in error, but the error is in opposite directions by the same percentage, so that the mean of the two should give the correct value.

The mathematical proof for the last two steps is, for the sake of briefness, omitted.

$$\text{Then, } Q = \frac{Q_1 + Q_2}{2} = \frac{1}{2}\left(\frac{X_1}{\triangle X_1} + \frac{X_2}{\triangle X_2}\right) \quad (24)$$

And changing the right hand term of equation (24) from a reactive to a capacitive form, Q becomes:

$$Q = \frac{2C_r}{\triangle C_1 + \triangle C_2} \quad (25)$$

and the corresponding values of resistance and inductance become:

$$R = \frac{\triangle C_1 + \triangle C_2}{2W^2 C_r^2} \quad (26)$$

$$L = \frac{1}{W^2 C_r} \quad (27)$$

Adding the distributed capacity to the equations, formulae (25)-(27) become:

$$Q = \frac{2(C_r + C_d)}{\triangle C_1 + \triangle C_2} \text{ or } \frac{C_r + C_d}{\triangle C} \text{ (approx.)} \quad (28)$$

$$R = \frac{\triangle C_1 + \triangle C_2}{2W^2(C_r + C_d)^2} \text{ or } \frac{\triangle C}{W^2(C_r + C_d)} \text{ (approx.)} \quad (29)$$

$$L = \frac{1}{W^2(C_r + C_d)} \quad (30)$$

The test procedure involves measuring the (C_d) of the coil by the method previously described and then obtaining the anti-resonant capacity and the capacity changes to the two 70.7%-antiresonance-impedance points.

In the foregoing derivation there are two possible sources of error. The first possible error may be attributed to the fact that the effect of harmonic content of the signal voltage has not been considered. However, this error was shown to be negligible in one of the preceding paragraphs.

The second error may be due to the change in line current resulting from a change in tank-circuit impedance. This source of error was eliminated by providing feedback to the buffer amplifier.

Condenser "Q"

Due to the fact that for economical reasons no calibrated inductometer was made available, measurements of condenser Q's are made somewhat more complicated. Nevertheless, the test procedure is still fairly simple. It involves measuring the Q of the wave-meter circuit alone, using one of the high-"Q" coils provided for this purpose, and then repeating the test with the unknown condenser connected. The circuit involved is shown in figure (5) in which, for the sake of simplicity, the circuit parameters are represented by their parallel equivalents.

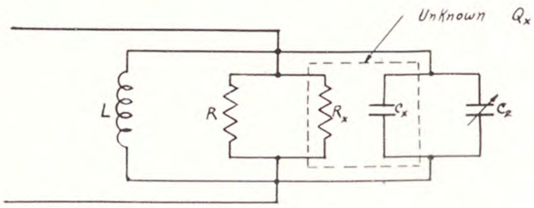

Figure 5

Consideration of this circuit shows that the respective "Q" values are directly proportional to the resistance involved,

$$\text{or } Q_1 = \frac{R}{X_L} \text{ and } Q_2 = \frac{R_e}{X_L} \quad (31)$$

$$\text{and } \frac{Q_1}{Q_2} = \frac{R}{R_e} = \frac{R}{\dfrac{R\,R_x}{R + R_x}}$$

$$= \frac{R + R_x}{R_x} = \frac{R}{R_x} + 1 \quad (32)$$

Formula (32) can then be modified to

$$\frac{Q_1 - Q_2}{Q_2} = \frac{R}{R_x} = \frac{Q_1 X_L}{Q_x X_x} = \frac{-Q_1 \dfrac{1}{C_1}}{Q_x \dfrac{1}{C_x}}$$

but $C_x = C_1 - C_2$

$$\therefore \frac{Q_1 - Q_2}{Q_2} = -\frac{Q_1(C_1 - C_2)}{Q_x C_1}$$

$$\text{and } Q_x = \frac{(C_2 - C_1)Q_1 Q_2}{C_1(Q_1 - Q_2)} \quad (33)$$

If coil (C_d) is taken into consideration, (33) becomes

$$Q_x = \frac{(C_2 - C_1)Q_1 Q_2}{(C_1 + C_d)(Q_1 - Q_2)} \quad (34)$$

and in terms of condenser-dial readings,

$$Q_x = \frac{(C_2 - C_1)(C_2 + C_d)}{\triangle C_2 C_1 - \triangle C_1 C_2} \quad (35)$$

Two-Terminal Impedance

The test procedure outlined under condenser-Q measurements lends itself exceptionally well to the measurement of any two-terminal impedance. Because of this similarity only the test circuit involved, figure (6), and the final formulae will be shown.

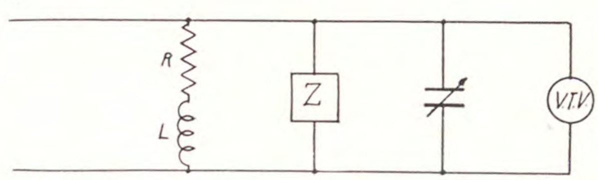

Figure 6

The various components of the unknown are represented by the following formula in which the subscript p indicates the parallel-equivalents.

$$Q_x = \pm \frac{(C_2 - C_1)Q_1 Q_2}{(C_1 + C_d)(Q_1 - Q_2)} \quad (36)$$

$$R_p = \frac{\pm Q_1 Q_2}{(C_1 + C_d)(Q_1 - Q_2)W} \quad (37)$$

$$X_p = \pm \frac{1}{W(C_2 - C_1)} \quad (38)$$

$$L_p = \frac{1}{W^2(C_2 - C_1)} \quad (39)$$

$$C_p = C_1 - C_2 \quad (40)$$

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(Continued on page 21)

SOME FUNDAMENTALS OF GEOLOGY

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Any investigation into the application of geology to engineering work brings to light the vastly widespread diversity of application which includes nearly all phases of Civil and Mining Engineering, much of Military Engineering and varied economic and industrial applications with which the engineer from time to time must be concerned.

Regardless of the application to be made, the fundamentals remain the same, and it is of these fundamentals with which this paper is interested. The word "Geology" is from two Greek words signifying "The Story of the Earth." As used in science it means an account of the rocks which lie beneath the surface and stand out in the ledges and mountains, and of the loose sands and soil which cover them, and also an account of the early history of the earth as told by the rocks. This science of geology however, can be, and often is further sub-divided according to the part of the whole science which treats of a specific field. *Dynamic Geology* deals with the forces now at work in changing the surface of the earth, and its accompanying chemical and mechanical change. *Structural Geology* is a study of the materials of which the earth is composed, and of the arrangement, with explanation of the ways in which the present arrangement was produced. *Physiographical Geology* is a study of the relief of the earth, that is, its valleys, mountains, streams, and how they were produced. *Petrology* treats of the rocks only; their formation and constitution. Some authorities use the term to apply to igneous rocks only, but this meaning is not always intended. *Economic Geology* deals with the mineral resources of the area under consideration. This includes metals and metal ores, mineral fuels and miscellaneous non-metallic minerals such as clays, cement, building stone, etc. *Cosmology* deals with the relationship of the earth to other heavenly bodies. *Paleontology* is the study of ancient life as indicated by the fossil remains found in the rocks. *Mineralogy* deals with the minerals which compose the rocks of the earth's crust. *Historical Geology*, which is perhaps the most important in tying together the fragments and combining the findings of the other groups, sets up the chronological sequence of events from the earliest times on to the present.

As a means of acquainting the reader with many of the terms which have been built up around the science, it is my intention to outline several of the branches of geology just defined. Before considering the theories which have been advanced it seems wise to consider the means by which these theories have been developed. Much of the geological theory has been based on the findings indicated by present day borings, geophysical exploration and observation at the site of excavation. By combining this knowledge and observing present surface changes, hypotheses may be set up which are the basis of our present geological knowledge. No man in his life span has observed the folding of the earth's crust, nor has he been able to observe the cutting away of hard granite or basalt ridges by running water, but by summing all these minute actions and multiplying by the millions of years which have passed, it may be deduced that these phenomena have taken place. It is well to remember, too, that many of these hypotheses have been set up in the light of knowledge up to the present time, and that future findings may alter the hypothesis. The result of this change in theory from time to time is not harmful. It is far better to set up definite theories, even though they are later proved wrong, than to merely have an accumulation of unassembled data.

Dynamic Geology

It has been suggested that we might draw an analogy between the physical and chemical actions in the human body, called physiology, and the corresponding changes of the earth and call Dynamic Geology the physiology of the earth's crust. While the analogy is not complete it is helpful. Dynamic Geology deals with the volcanoes and earthquakes and the destructive and constructive processes of the atmosphere, water and ice. The common thought of volcanic action is that of a single conical vent belching molten lava or volcanic ash. There are other less spectacular but equally important ways in which nature forces lava toward the surface of the earth. The two principal phases of this lava rise are termed extrusive and intrusive. Extrusive lava flows are those which reach the surface and intrusive flows are those which are halted below the surface. First and Second Watchung Mountains are examples of extrusive lava flows. Geologists know this by the formations showing a surface cooling. The rocks locally known as "Turtle Back Rocks" show this type of cooling. The Palisades is an example of an intrusive lava flow, known as a sill. This type of flow may be determined, not only by the adjacent layers but by the evidence of a change in structure adjacent to the intrusive flow. Intrusive deposits may subsequently be uncovered by erosion and are often found on the surface. Similarly, extrusive flows may be covered by deposition, as by glaciers, and thus are sometimes found below the present surface. Types of intrusive formations have such names as sill, dike, plug, laccolith and batholith, according to shape. These are all formed as subsurface structures.

Extrusive agencies include volcanos and fissures. The essential difference between these is that fissures, while not as active and violent, may occur along as great a length as two hundred miles. The volcano on the other hand may be very violent but confine itself to a single vent, building up a cone of lava and ash as it erupts. In parts of the country where volcanic rock is found, special investigation must be made if this rock is to be used as a foundation. Failures of many structures and many construction difficulties have been encountered because of the presence of volcanic rock.

Another dynamic agent in the changes on the earth's crust is seismic action or earthquakes. This is a natural adjustment of the surface of the earth to compensate for internal contraction of the earth as it cools.

Earthquakes occur along regular lines, and zones of seismic action have been set out which indicate the location of the most violent earthquakes. In this country this zone follows closely the western part of the United States. This zone also continues through western Canada, and south through central and western South America. As an example of the work done by earthquakes, the San Francisco earthquake of 1906 covered an extent of 270 miles with a maximum horizontal movement of 21 feet. In this case there was little vertical movement, but in some earthquakes (as at Yukatat Bay, Alaska) vertical movements as great as fifty feet have been recorded. This is sufficient to alter the topography of an entire region.

Folding and faulting are two other types of diastrophism which tend to alter the earth's surface. If we consider for a minute the action which takes place on the surface of an apple as it becomes somewhat mellow and starts to dry we can see a miniature example of this contraction. The wrinkles in the apple and the folding and warping of the crust of the earth are very similar. When we consider that the diameter of the earth is approximately 8,000 miles and that the greatest range between the highest peak and the lowest depression on the surface of the earth is about twelve miles, we see how well the example fits. Folding and faulting are similar in final results to the seismic action mentioned, but operate in a more slow and gradual manner. Folding consists of a slow compressing of the layers of the earth's crust such that they form a series of looping rather than horizontal layers. If we were to take a ream of paper and compress it from the sides only we would duplicate the folding action which takes place. Mountain ranges are formed in this way and it has been computed that the "shrinkage" in the circumference of the earth may be as much as hundreds of feet for a single mountain range. Types of folds are referred to as anticlines and synclines according to their predominant direction of folding. Where a series of many folds are adjacent, the mass is termed either an anticlinorium or a synclinorium. Faulting is the fracture of rocks along a definite line, resulting in a displacement of one side with respect to the other. Faults may have only a vertical displacement, causing a discontinuity of corresponding layers, or may combine horizontal and vertical action. The former is known as a closed fault, and the latter as an open fault. The displacement may be a few inches, or it may be hundreds of feet.

Weathering, or the action of the atmosphere and temperature changes, is a very active agent in the breaking down of the surface structure of the earth, and along with this the wind may serve either as an agent of destruction or reconstruction as it erodes and redeposits material. A common example which illustrates the effectiveness of weathering is graveyard markers. Both marble and granite show signs of this weathering, and slate, which was formerly much used, is often worn sufficiently to remove all signs of the early printing. This action furnishes material for running water to use in its corrosive action. Running water has its effect in cutting deep and wide valleys, in cutting through solid rock formation, and in carrying unbelievable quantities of eroded materials to its mouth, there to deposit them and build deltas consisting of millions of cubic yards of material.

All of these actions and many more less obvious have combined to perpetuate a constant struggle between the tearing down of the higher land and the building up, either by deposition or diastrophism, of the lower areas. This cycle is known as the erosion cycle, and consists of uplift, that is the folding and warping of the earth's crust forming hills and mountains, which is followed by erosion aided by weathering, tending to reduce the entire area to a common level. This latter is termed "base-leveling." This is closely allied with Physiographic Geology which will be referred to later.

Structural Geology

Under structural geology we find three distinct rock types. These are known as Igneous, already referred to under dynamic geology, as the original rock magma deposited either as intrusive or extrusive layers. Common examples of these are granite and basalt. Also included under igneous rocks are pyroclastic rocks which are ejected by volcanos, often forming a rather porous rock known as tuff, as well as more dense rocks. The second division is Sedimentary rocks. These are usually considered as having been laid down under water and then having been cemented together by later action, usually land subsidence, which increased the pressure upon that strata as well as to allow another layer, perhaps of another material, to be deposited upon it. Sandstone and conglomerate are common examples of this type of rock, which was originally water borne, and then became a separate strata. Limestone or dolomite also is indicative of the presence of water at some past time, as this formation is often the remains of ancient shell-fish, the disintegration and cementation of the particles of shell forming the limestone. Bituminous coal, as is commonly known, was laid down in a similar way, but from vegetable matter, during what is known as the Carboniferous age. This type of coal was formed from prehistoric peat bogs. The third major division of the structural types is Metamorphic. Metamorphosis means change, and a metamorphic rock is changed from another form, as from the igneous or the sedimentary. There are two major forms of metamorphism as related to rocks. Contact metamorphism means the change which has taken place in a strata because of the presence of hot magma immediately adjacent to it. At this zone of contact the intense heat has brought about complete chemical and physical changes in the structure of the rocks. Dynamic metamorphism is the change which takes place in an original rock bed because of the shifting caused by the faulting, folding and warping of the earth's crust with the accompanying production of heat. From this cause we find new rocks being formed, as slate from clay deposits, marble from limestone, gneiss from granite, and anthracite from bituminous coal. It would be incorrect to assume that these changes are all definite and distinct. There is a very gradual change from the outside to the inside zone of contact as might be suspected, and the gradation is so slight that the actual determination of a rock type is very difficult. This is true of almost all rock determination because the range of variation in chemical composition is very great and all three of the rock types have their counterpart, each in the other.

Physiographic Geology

As mentioned in a preceding paragraph there are two opposing agencies, one tending to upheave any region and thus increase its elevation, and the other tending to cut down the land to the level of the sea. Physiographic geology is concerned with the result of this action and depicts the record of the progress of these two agencies. This variation in elevation is known as the relief of an area. The principal forces at work to carve out the valleys and erode the ridges are wind and water. In the early stages of the erosion cycle there are many small streams, gullies are formed and steep ridges are left. As the erosion pattern becomes more mature, the streams are fewer in number and are wider; the gradient is decreased, and this cuts down the velocity with the result that there is more meandering and lateral cutting, known as lateral planation. In the old age stage of the erosive action there are few hills left and they are well rounded, the streams meander through the broad valleys, the gradient having been further reduced by the erosion which has taken place. The wind has also eroded to the point of smoothness the existing exposed rock formations and the area as a whole is quite flat.

Under this phase of geology we might also include the effect of glaciers, both Alpine and Continental. Alpine glaciers are those found on the high mountain ranges as in the Swiss Alps. These glaciers flow very slowly down the valleys, untimately forming broad U-shaped valleys and, finally melting, serve as feeders to the mountain streams. Continental glaciers, however, are those which cover large areas of the country, such as the glacier which in early time covered all of Canada and the northern portion of the United States. By the transportation and deposition of great quantities of earth and gravel the topography of the area was greatly changed; in some cases we find glacial drift or till to a depth of several hundred feet. Kettle-holes were formed where the ice melted and left these scars; eskers, drumlins, kames and ridges are formed where the glacier ceased its southward march, and outwash plains and frontal aprons indicate where the material from these glaciers melted and carried with the running water much of the material which may have been carried hundreds of miles as englacial or superglacial material. All of these agencies are, or have been, at work to change the topography of the country, and with them Physiographic Geology deals.

Petrology, Economic Geology, Cosmology and Paleontology have been defined, and their interests are not as closely allied with the ordinary work of the engineer in geology as some other branches. A knowledge of geology is essential for the study of these branches, however. Mineralogy is of prime importance to the engineer because minerals are the constituents of the rocks and as such are essential. A mineral differs from a rock in that the former has a definite chemical composition, whereas a rock may vary considerably in composition and still be classified under the same heading. Mineral determination is based on a study of the physical properties of the specimen. The properties usually considered are hardness, cleavage, luster, streak, color and specific gravity. The Hardness scale, known as the Moh hardness scale, is arbitrarily set by ten common minerals ranging from Talc as number one, or softest, to the Diamond as number ten, or hardest. Cleavage is the natural tendency to part readily along definite planes. Luster is the appearance of the mineral in reflected light. Metallic (or non-metallic) streak is the color of the powder of a mineral, determined by scratching the mineral on a piece of unglazed porcelain. Color is determined by comparison with a standard color set. There are other tests which further identify minerals, and the differences are noted until the unknown is determined. Determination tables have been made up listing all minerals under the headings listed above in such a way that by a process of elimination the correct name is arrived at.

Historical geology deals with the Chronological story of the formation of the rocks of the earth, continental changes, and the physiographical changes which have taken place in the past. There have been changes in climate and a succession of animal species from the protozoans up to man. For convenience in referring to definite times in the history of the growth of the world geologists have divided all time into four eras, the eras are divided into periods, and the periods into epochs. The first era was the Achaen or era of no life at all. This is set by some as far back as 1600 million years. The next era was termed the Paleozoic Era, or the era of ancient forms of life. These are followed by the Mesozoic and the Cenozoic Eras, meaning middle and recent life. During the Paleozoic Era we find evidence of invertebrates and fishes, and during the Cenozoic Era we find the indications of mammals and man. Geologic time scales are subject to much variation, according to which authority one prefers to quote. The following approximations are from Hotchkiss:

Paleozoic Era	360 Million Years
Mesozoic Era	120 Million Years
Cenozoic Era	60 Million Years

Historical geology has aided in the determination of the sequence of the layers of the earth's crust; by fossil remains it has been able to definitely picture the type of animal life existing during each period and by that has established a criterion by which the succession of layers may be determined. Historical and structural geology have aided each other, and through a study of fossils we have arrived at a better understanding of the sequence and order of the earth.

Comments by Professor Harold N. Cummings, in charge of Civil Engineering Department of the Newark College of Engineering

Mr. Daniel C. Frost has been a member of the staff of the Civil Engineering Department since September, 1936. His particular contribution to the department has been in the field of geology and physiography, and especially in the introduction of field trips in connection with the local aspects of geology, and of laboratory studies of rocks and minerals with special attention to local sources of such of these materials as are of engineering interest. He is a graduate of Northwestern University, and in addition holds graduate degrees from Thayer School of Civil Engineering at Dartmouth and the School of Education at Rutgers. His professional society memberships include the American Society of Civil Engineers, Boston Society of Civil Engineers, Montclair Society of Engineers, and the Society for the Promotion of Engineering Education.

NAMED ADVISER FOR TRAINING

Allan R. Cullimore to Coördinate Defense Work in Colleges

(from *Newark Evening News*, Nov. 4, 1940)

Allan R. Cullimore, president of Newark College of Engineering, has been named adviser in the northern area of New Jersey for the program of training technicians for defense work. This was announced today by A. A. Potter, consultant to the United States Office of Education.

Cullimore will have the task of coördinating the work in the training program of Newark College of Engineering, Princeton University, Rutgers University, and Stevens Institute of Technology. He also will coöperate with other regional advisers in "insuring that institutions with the best facilities are utilized for engineering defense training," Potter said.

Courses of study under the program will be financed by the government. They will be given for those able to devote their entire time to preparation for future defense jobs and for workers now employed who desire to fit themselves for more responsible assignments. The courses, which will require from two to eight months of study, will concentrate upon training of immediate practical application to specific defense jobs.

TEACHERS FROM INDUSTRY

Classes will be held both at the engineering school and in or near industrial plants for the benefit of part-time and evening students. The regular college teaching staffs will be supplemented by additional teachers, including specially qualified men from the industries to be served.

In most cases, according to the office of education, students will be selected from those who previously have had some technical training or practical experience in it and who need their skills refreshed or supplemented in order to fit them for specific technical or supervisory duties. The work given will be on the level of that for college degrees and will not conflict with the emergency training program in the vocational schools.

Educational institutions desiring to take part in the program have been asked to submit preliminary plans, stating the need for trained technicians in their areas, facilities and personnel available to give necessary courses, number of students that can be taught, and the approximate cost of instruction. Announcement of first courses to be offered and the institutions where they will be available was expected to be made about November 18.

LIAISON OFFICER

According to the office of education, Cullimore's duties will include acting as liaison officer, maintaining continual contact with defense industries, army and navy district offices, employment services and other sources of information on personnel needs.

Federal allotments to the participating colleges may be used to meet the costs of salaries, materials, and supplies, reference books, operation of buildings, maintenance and repair of equipment, and, to a limited extent, the purchase or rental of additional equipment, and the leasing of space in non-college buildings. No expenditures were authorized for the purchase or construction of buildings, nor was provision made to defray the living expenses of students. Students will pay no tuition charges. Congress has appropriated $9,000,000 for the program.

ECONOMICS FOR INDUSTRIAL ENGINEERS[1]

By GEORGE D. WILKINSON, JR., B.S., M.S.

Associate Professor in Industrial Engineering, Newark College of Engineering

Every thoughtful industrial engineer gives attention, at some time in his career, to the social implications of his work. If he has a tendency to ignore the subject in the enthusiasm of doing a job well, the continual criticism leveled at him by his socially minded contemporaries and by the workers whose jobs he imperils goads him to take steps to justify himself. A naive example of this reaction is his vigorous assertion that he is not an "efficiency man." He has a comfortable feeling that if he can only separate this odious term from his profession, he will once more establish himself as a respectable, constructive member of society. Some engineers, realizing that the solution of the dilemma must go far deeper, have attempted to formulate an economic and social philosophy that will reveal the constructive side of their work.

Although this effort in itself is praiseworthy, too many engineers have approached the problem in much the same frame of mind as those who seek to erase the pernicious term of "efficiency man" from the public memory. Far from building their thoughts upon a study of the present-day working world in which they find themselves, they have tried to construct a social credo upon a combination of outmoded economic dogmas and unmitigated wishful thinking. The purpose of this paper is not to propose a complete social and economic philosophy, but rather to examine critically one of the most common of the expressions proposed by industrial engineers. Stated simply, this expression can be summed up as follows: "The greater efficiency which results from our work means lower prices for the products we are making. The lower prices make it possible for more people to buy our goods, and the increased sales make it necessary for us not only to keep all of our present workers, but to employ even more."

A critical analysis of this theory prompts four questions, which must be answered completely in the affirmative if its validity is to be unquestionably established:

1. Is the productivity of the worker increasing? If the answer is "yes," then,

2. Are prices going down because of the increasing productivity?

3. Are more goods being sold as a result?

4. Are enough more being sold to re-employ all of those workers who are made unnecessary because of technological developments?

In this paper, current economic and business statistics will be cited in an attempt to arrive at answers to these questions. The intention of the author is to show that no unqualified affirmative can be given to the last three of the above questions, and that the entire theory must, therefore, be subjected to a thorough revision before it is in accord with the real economic situation.

Productivity of the Worker

The answer to the first question is the easiest. Few people would contend that the worker today is not producing more per labor hour than at any time in the past. A survey of fifty-nine manufacturing industries made by a national research project and published in 1939 reports that the worker in 1919 had an output per man hour of only 69.1 per cent of the worker output in 1929, and that by 1936 this productivity had increased 23.9 per cent over the 1929 level. Engineers need not turn to the economists for data of this sort. In the Tranactions of The American Society of Mechanical Engineers for 1939, Alford and Hannum reported the productivity of fifty manufacturing industries, comparing performance during the period from 1923 to 1931. They found that the number of workers required to produce the output of 1923 decreased from 67,824 in 1923 to 58,211 in 1931. Putting it another way, to produce as many goods in 1931 as were produced in 1923, and at the same time to employ as many people, the work week would have to be decreased from 51.2 hours to 35.4 hours. Other data could be cited to support this point, but there is no need to labor the obvious.

Prices

Are prices going down as a result of this increasing productivity? Here the answer is not clear-cut. Examples of both increasing and decreasing prices are readily obtainable. The automobile retailed at an average figure of $1,115 in 1914, according to the Automobile Manufacturers' Association. In 1938, the average car cost $783. In the same period of time, electric light bulbs decreased in price from sixty-three cents to fourteen cents. Electric fans sold for $12.20 in 1914; for $2.75 in 1938. In 1921, when rayon was still in its infancy, it sold for $2.69 a pound. Since that time, with very few exceptions, it has sold at a steadily decreasing price, until in 1939 it sold for $.51, less than one-fifth of its price two decades ago.

There are endless examples of falling prices as a result of the engineer's work, but the numerous examples of goods which now sell at the same or higher prices, even though many technical developments have taken place in the industry, must not be ignored. The automobile has already been mentioned as a product whose price has fallen. Between 1914 and 1938, the two years for which prices were quoted, almost a quarter of a century elapsed. Most of the fall in automobile prices occurred during the early part of that time. In 1929, a period of high prices, the average f.o.b. price of a car was $773.00. By 1933 this price had fallen to $671.00, but prices in general had fallen during that time by about 30 per cent, so that automobile prices, relative to general prices, had actually risen. By 1937 the average price had risen to $717.00. Although the automobile industry has been in the forefront in technical development, lower prices have not been a result during the past decade.

Drugs and toilet articles which cost $1.00 in 1914, cost $1.41 in 1938. Tobacco which could be bought for $1.00 in 1914 now costs $1.12. A year's supply of clothing for a family of four during the same time has increased in cost from $175 to $218. An article in the New York *Times* for January 2, 1940, told an interesting story about steel. It explained that the steel industry had just completed an enormous reconstruction program costing millions of dollars. High-speed rolling mills and similar engineering developments had been built into the industry. Naturally, one would expect that such improvements would result in lower prices. To quote the article: "So far as can be judged by the experience of recent years, the customers of the steel industry have been the principal beneficiaries of the reconstruction program that has been effected, as they may purchase a wider range of products, of better quality, *at 1929 Prices*." (italics ours.) In spite of all other progress, in spite of a wider range of products and of better quality, the technical

[1] Paper presented at a meeting of the Time and Motion Study Group, Metropolitan Section, The American Society of Mechanical Engineers, January 18, 1940. Reprinted with permission from *Advanced Management* for July-September, 1940.

advances of the past ten years have not seen lower steel prices.

The answer to the second question, "Are prices going down?" is, then, both yes and no. Where prices are going down, their decline in many cases can be traced almost directly to improvements wrought by engineers. Other prices, in spite of technical improvements, have not declined, and many have increased. The reason for the failure of some prices to respond to technical improvements will be treated later in this article. The important point here is that technical improvements do not necessarily lower prices.

Sales

Are more goods being sold because of decreased prices? Many homely examples belie the theory that because the price goes down, more goods are bought. During the past few years, the price of bread has decreased from thirteen cents to ten cents a loaf. How many people have increased their consumption of bread as a result? If the price of toothpaste were cut in half, would individuals use twice as much? Many articles which are bought and used habitually would scarcely find greater use if their prices were decreased.

On the other hand, many commodities behave in exactly the opposite manner. The sale of electric light bulbs has increased steadily as prices have decreased. The fall in the price of automobiles was accompanied by a corresponding increase in sales. It is interesting to note that the rapid increases in automobile sales stopped at about the same time that automobile prices stopped declining. Rayon, whose price history has already been mentioned, has enjoyed a steady rise in sales. Actual statistics to answer the question are difficult if not impossible to get, because sales are influenced by many factors other than price. Style changes and population trends often have greater bearing upon sales volume than have prices alone. From a consideration of the foregoing examples, however, it seems evident that this question, like the preceding one, cannot be answered with a simple "yes" or "no." The sales volume of some commodities will increase if the prices are lowered. For many others, a change in price will have relatively little effect.

Technological Unemployment

Are enough more commodities being sold to reabsorb those workers who would otherwise be displaced by technical improvements? To state it more accurately, do the sales of those commodities responsive to price changes increase as fast as the productivity of the workers increases? Again no definite answer can be given. In the rayon industry, between 1929 and 1937, productivity increased 141 per cent. Prices fell, and sales volume increased by 181 per cent. The increase in sales was enough to offset the increase in productivity, and the result was an increase in man hours worked of 16.6 per cent, and of employment of 48.3 per cent. On the other hand, automobile production was only 85.3 per cent of its 1929 level in 1936, and the number of man hours had fallen off, in the same period, to 73.7 per cent. In the glass industry production increased 16 per cent while man hours worked decreased 28.5 per cent and employment decreased 3.2 per cent. Thus, decreases in price and increases in sales volume do not always result in the employment of more people.

Increasing Unemployment

To stay within the scope of this paper, many important factors in the current economic situation must be disregarded. Yet the fact remains that, since the productivity of the worker is constantly increasing, one or more of the following events must take place if the economy is to function properly:

a. hours of work must decrease
b. wages must increase
c. prices must go down so that purchasers can buy more either of the same commodity or of some other commodity.

All these mitigated events have appeared to some extent. The work week has decreased from seventy-two hours to forty in most industries. Many concerns, in a valiant effort to keep as many people as possible employed during the depression years, reduced their work weeks much further, but this action cannot be considered normal. Wages are increasing. Although much credit for this fact must be given to greater union activities, the trend toward higher wages was established before the C.I.O. came into existence. The doctrine of high wages and low labor costs, formulated by Frederick W. Taylor, has for years been the guiding principle of progressive industrialists in this country. The National Industrial Conference Board is quoted as saying that the hourly wage of the factory worker increased from \$.25 in 1914 to \$.71 in 1938. Weekly earnings increased from \$12.68 to \$26.03 during this period, although hours of work declined from 51.5 to 36.6 hours per week. The doctrine of high wages and shorter hours has not found universal acceptance, however, and many examples can be cited of wages being increased and hours decreased only under the severest compulsion.

In regard to prices, we have already seen that increases in productivity are not always accompanied by decreased prices. An important reason may be that technical changes resulting in greater productivity may occur in the face of increased costs to the industry. Rising prices of wool accounted for increased prices for clothing even when labor costs were decreasing. Real factors in this situation today are increases in wages because of union activity, and higher taxes. Many industries, faced by rising costs in these fields, are forced to improve their technical processes, not to decrease prices, but to maintain them at their present levels. At times improvements are made while the volume of business is decreasing, so that lower labor costs are absorbed by the necessity of distributing the overhead over a smaller number of products. The same effect is obtained if a new plant embodying the latest technical devices is built in anticipation of an expansion of business that does not materialize. Much of the failure of steel prices to reflect technical improvements can probably be attributed to this cause. Very often technical improvements mean a better product, but not a cheaper price. Automobiles, for example, have been the object of many improvements during the past several years. Although these technical advances mean a better car for the money, they cannot be expected to increase the sales of cars or to provide greater employment, because the price has not decreased. Another reason why prices do not fall is the fact that much technical effort is wasted in preserving the competitive position of the individual companies that make up our economy. A saving of thousands of dollars by an engineer in the operating department of an enterprise may be absorbed by an additional expenditure of a like amount for the services of a comedian to persuade radio audiences to switch their purchases from a competitor. Finally, prices are often not responsive to technical changes because the industry may be under some degree of monopoly control. Habitual prices, price-fixing agreements, or patent controls may make it possible for industries to charge a price far in excess of the real cost of production.

To some degree, then, hours or work have decreased, wages have increased, and prices have fallen. Yet according to the best available data the number of people unemployed in this country has been steadily increasing during the past several decades. Although no accurate statistics on the number of unemployed in this country were available until 1937, when the census of unemployment was taken, the various estimates tend to bear out the same fact. The following table is one such estimate, showing that every period of prosperity is accompanied by a larger number of unemployed than the preceding period.

TABLE 1.—THE UPWARD TREND OF UNEMPLOYMENT, 1900-33

Years	Character of Period	Yearly Average of Workers Unemployed	Per Cent of Workers Unemployed
1900-06	Prosperity	657,000	7.6%
1907-09	Depression	1,091,000	10.7%
1910-13	Prosperity	877,000	7.9%
1914-15	Depression	1,860,000	15.9%
1916-20	Prosperity	817,000	6.4%
1921-22	Depression	2,625,000	20.7%
1923-26	Prosperity	1,149,000	9.0%
1927-29	Prosperity	1,250,000	9.5%
1929-33	Depression	5,400,000	35.2%

Source: "The Decline of American Capitalism," Lewis Corey, Covici-Friede, Inc., 1934, page 242.

Conclusions

An attempt can now be made to answer the initial question of this paper: How can the industrial engineer justify his work in the face of the economic and social maladjustments which often seem to follow in his wake? Many of the favorite theories that industrial engineers use to remove the disgrace of their calling in the eyes of the world have been seriously questioned in this paper. It seems to the writer that most of these theories have been based upon wishful thinking, and have not been substantiated by a comparison with facts. Engineers owe it to their profession to be honest with themselves.

What can an industrial engineer say to justify himself? The most obvious point he can make is that better methods raise the ceiling for wages. In the economic system in which we live a man cannot consistently receive more in wages than he contributes in services to his employer. Any firm which paid its workers more than they produced would soon be out of business. No matter how pressing may be the needs of the workers, and no matter how well they may be organized, they cannot expect to get more than they produce without bringing upon themselves ultimate ruin. The only way in which wages can be safely raised is by producing more goods, and one of the best ways of doing this is to eliminate soldiering and waste motions.

A second point he can raise is that he is making it less and less possible for workers to be exploited, knowingly or unknowingly, by their employers. He is finding out by scientific methods how much work a man should be asked to do during a work day in the shop, and he is showing the worker how to do it most efficiently. This information makes it possible for management to treat its men with more honesty and fairness than it could when wages and tasks were determined by the whims of the supervisors.

A third argument is that the industrial engineer may act to offset other tendencies that would eliminate labor. Many cases could be cited in which the introduction of a labor-saving machine was under consideration and was prevented by the discovery of a more efficient way of doing the same task by hand. Labor has an advantage over the machine in that it is not a fixed overhead charge, and industrial engineers can save many jobs for labor by finding better ways of working with the hands.

The final argument is not quite as academic as the others. The average worker does not care particularly if someone else is thrown out of work, so long as his own job is preserved. From this point of view, the industrial engineer has much to say. The products made in any plant are competing, not only with similar products made by other plants, but with every other commodity for which the consumer may spend his dollar. The radio is competing with the automobile, and the baker's pie with the druggist's ice cream. Brand A shoes are competing with Brand B shoes. Every plant must, therefore, keep itself in a favorable competitive position. This means that every worker must work in the most effective manner, so that the ultimate product can be sold at the cheapest possible price. Unless this is done, the orders will go to a competitor, the plant will fail, and the workers will be among the numbers of the unemployed.

All of the arguments up to this point may be used to justify the activities of the industrial engineer to the employes in the plant, but they very neatly avoid the real question that such engineers are asking themselves: How important are increased wages and decreased hours and prices, when unemployment is constantly increasing in spite of these factors?

In the face of such a question engineers can, if they choose, take refuge in the fact that the responsibility for unemployment does not lie with them. All the technical progress that has been made during the past years has resulted in a higher standard of living for those who have come in contact with it. Strictly, as an engineer, the duty of a time and motion study man is plain. If the benefits he provides are not used wisely, and if social injustice results, that is not his professional responsibility.

On the other hand, in a democracy each person is individually responsible for the direction of the social order. If as engineers we are not responsible for the way that our work is used, as citizens we are. The individual engineer, working for his particular employer, has nothing to say about the larger issues of this problem. But the engineer, through the exercise of his ballot, and through the activities of his professional organization, can take an active interest in the economic system under which we operate, and should make all of his technical training available to society.

Certainly no one person knows how the economic system can be run so that labor saving devices will mean less work instead of unemployment, and this paper has not attempted to set forth any plan for accomplishing such an end. It is an important problem, however, and the ultimate solution will be found only if engineers are willing to face the facts honestly, and on the basis of these facts to contribute their training and skills, along with those of the lawyer, the economist and the politician.

GRADUATE STUDENTS—NEWARK COLLEGE OF ENGINEERING

Newark College of Engineering is offering this year for the first time certain graduate courses to engineering graduates and others properly qualified. By agreement between the Newark College of Engineering and Stevens Institute of Technology these graduate courses are coördinated with the offerings of the Graduate School of Stevens. Graduate engineers who earn graduate credit in these courses given by the Newark College of Engineering may have their credit applied towards meeting the requirements for an advanced degree at Stevens Institute.

Dr. T. Smith Taylor, in Charge of Graduate and Advanced Studies, announces that during the present semester a total of 103 graduate students have registered in these courses. Of the students registered, 47 are graduates of Newark College of Engineering and 56 are graduates of some 35 other institutions. Of the 56 students who are graduates from other institutions, 8 are from Stevens Institute of Technology, 4 from Princeton University, 3 each from Purdue University, Cooper Union School, and Polytechnic Institute of Brooklyn; 2 each from Rutgers University, New York University, Cornell University, Pennsylvania State College, Saint Peter's College, and University of Notre Dame. Other institutions represented include: Yale University, Harvard University, University of Minnesota, Colgate University, Worcester Polytechnic Institute, Bucknell University, Columbia University, Case School of Applied Science, Lehigh University, University of Alabama, Virginia Polytechnic Institute, Ohio University, etc. A total of 21 of those registered have specified their desire to have their credit in the courses counted towards meeting the requirements for an advanced degree at Stevens. A few of those registered are taking the courses for the purpose of securing information which may be of immediate help in connection with their present or future work. Many of the others are taking their first course in graduate work and will doubtless continue with other courses in the future, at which time they will become candidates for degrees.

The enrollment according to subjects, and the instructors in the respective courses being given this semester, are as follows:

	Course	*No. of Students*	*Instructor*
Ma 273S	Differential Equations	16	Professor Fithian
Ch 201S	Advanced Organic Chemistry	9	Professor Bradley
Ch 205S	Paint Technology	12	Mr. Bauder
Ec 285S	Motion Study	25	Professor Wilkinson Mr. Cooley
EE 241S	Electronics and Vacuum Tubes	12	Professor Fishman
ME 221S	Advanced Thermodynamics	8	Professor Walter
ME 223S	Heat Transmission	5	Professor Taylor
ME 225S	Physical Metallurgy	22	Professor Schweizer
ME 223u	Civilian Pilot Training Ground Course	4	Professor Carvin
		113	

Of those registered, 2 students are enrolled in three subjects, 6 are enrolled in two subjects, and the remaining 95 in one subject only.

It is anticipated that the number of students who will be enrolled in all courses during the second semester of this College year, which will open February 10, 1941, will exceed 125 as a result of other courses beginning at that time. Registration for the second semester will be under the direction of Dr. T. Smith Taylor, and will take place from January 27-31, 1941. Dr. Taylor advises that he is already receiving inquiries and conducting interviews, by appointment, relative to the second semester registration.

PROMOTIONS AND APPOINTMENTS

Mr. Allan R. Cullimore, President of Newark College of Engineering, has announced the following promotions at the College: William G. Anderson, formerly Departmental Assistant, was appointed Instructor in Mechanical Engineering; Frank A. Busse, formerly Instructor in Civil Engineering, was appointed Assistant Director in Personnel Relations; Elmer C. Easton, formerly Instructor in Mathematics, was appointed Assistant Professor in Mathematics; Dr. Paul M. Giesy, formerly Professor in Chemistry, was appointed Professor in Chemical Engineering; Dr. Joseph Joffe, formerly Associate Professor in Chemical Engineering, was appointed Professor in Chemical Engineering; and Dr. T. Smith Taylor, Associate Professor in Physics, was placed in charge of Graduate and Advanced Courses.

New appointments include the following: Edwin S. Camm, to Instructor in Mechanical Engineering. Mr. Camm was graduated in 1939 from Rensselaer Polytechnic Institute with a B.S. degree in Aeronautical Engineering. Elmer L. Devor, to Instructor in Industrial Engineering. Mr. Devor, who graduated in 1937 from Pennsylvania State College, for the last two years has been connected with Columbia University. Francis W. Fiala, a 1938 graduate of Pratt Institute, to Instructor in Mechanical Engineering. Dr. John E. Freehafer, to Instructor in Mathematics. Dr. Freehafer graduated from Lehigh University in 1931 with a B.S. degree in Physics, and in 1933 with a M.S. degree in Mathematics. In 1937 he obtained a Ph.D. degree in Physics at Massachusetts Institute of Technology, and has since been Instructor in Physics at Western Reserve University. Thomas Q. Gilson, to Instructor in Personnel Relations. Mr. Gilson obtained his A.B. degree in Economics from Princeton University in 1938, and has since been an Activity Secretary at the Y.M.C.A. in Bronx, N. Y. Harold Lipschultz, B.S. in Chemical Engineering from Newark College of Engineering in 1940, to Assistant Instructor. Dr. James H. Pitman, to Assistant Professor in English. Dr. Pitman graduated in 1918 from Rutgers University and received his Ph.D. degree in English in 1922 from Yale University. He has lately been Instructor at The Packard School in New York City. Ira A. Tumbleson to Librarian. Mr. Tumbleson received the A.B. degree in Education at Nebraska State Teachers College in 1928, and a B.S. degree in Library Science from the University of Illinois in 1930, and a M.S. degree in the same subject from the University of Michigan in 1937. Mr. Tumbleson has been acting Librarian for the last three years with Queens Borough Library. Alan H. Stillman, a 1935 graduate of Cornell University, who has for the last five years been connected with Cambridge Instrument Company, is made an Assistant Instructor.

The following graduates from Newark College of Engineering were appointed as Departmental Assistants: Herbert Gross, B.S. in Electrical Engineering, 1940; Seymour Lewis, B.S. in Chemical Engineering, 1940; Sidney Metzger, B.S. in Chemical Engineering, 1940; Gus E. Viscione, B.S. in Chemical Engineering, 1940; and Harold L. Weinberg, B.S. in Mechanical Engineering, 1940.

Other Departmental Assistants appointed were: Robert K. Haubner, who graduated in 1939 from Hobart College, and who received a M.A. degree in 1940 from Cornell University; and John R. Snow, who was graduated in 1940 from Cornell University.

The staff of the Newark College of Engineering has steadily been increasing as the following table will show:

	1938	*1939*	*Spring 1940*	*Fall 1940*
President	1	1	1	1
Professors	9	10	11	12
Associate Professors	7	9	10	9
Assistant Professors	16	16	14	16
Instructors	20	18	18	20

Assistant Instructors	10	12	14	15
Departmental Assistants	9	11	10	10
Special Lecturers	7	8	10	9
Others	2	2	4	6
Totals	81	87	92	98

PROFESSIONALITIES

John E. Hanle, B.S. in Chemical Engineering, 1936, Newark College of Engineering, presented a paper on the Spreading Properties of Reactive Phenolic Varnishes on Tinplate, before the Division of Paint and Varnish Chemistry at the Detroit meeting of the American Chemical Society on September 11, 1940. This paper, which will be published in Industrial and Engineering Chemistry, was based upon part of a thesis submitted by Mr. Hanle to the Graduate Faculty of the Polytechnic Institute of Brooklyn in partial fulfillment of the requirements for his degree of Master of Chemical Engineering, which he received last June.

A. S. M. E. STUDENT CHAPTER GROWTH

Professor F. J. Burns, Honorary Chairman of the Student Branch of the American Society of Mechanical Engineers at Newark College of Engineering, reports that the enrollment of students in this society is heavy.

In the October issue of "Mechanical Engineering," published by the American Society of Mechanical Engineers, it is stated that the Newark College of Engineering branch is one of ten among universities having more than 120 members. It also states, "The greatest gain (last year) in enrollment was made by Newark College of Engineering, which increased its membership from 81 to 123, a gain of 52 per cent."

In the same magazine it also said, "Many of Newark's members were obtained during the first month of school. Shortly before the first meeting each prospective member received a personal letter in which A.S.M.E. activities were described. This was followed by a series of 'get-acquainted' posters placed on bulletin boards in order to further familiarize prospective members with the activities of the branch."

FALL CONVOCATION ADDRESSED BY DR. JACKSON

The second student convocation of the school year took place during the last period on Thursday morning, November 7, in Campbell Gymnasium. John Stillwaggon, president of the Student Council, called the convocation to order and presented Allan R. Cullimore, president of the college.

Mr. Cullimore stated that the country has elected its leader in making Franklin D. Roosevelt the president of the United States and that it is the duty of every citizen whether he voted for the president or not to "get behind the boss and give him all we've got." In such troubled times as we are experiencing today, it is essential and imperative that we all work together, he stated. Mr. Cullimore then introduced the guest speaker, Dr. Dugald C. Jackson, Professor Emeritus of Massachusetts Institute of Technology.

Dr. Jackson, who has had a long and distinguished career in teaching, educational administration, and consulting engineering, started his talk by telling the convocation something of the life of Charles Edison, the Governor-elect, whom he had taught while a professor at M. I. T. He stated that we have reached a period when we are guided by sentimentalism rather than by sound thinking, and that the nation does not owe a living to each individual, but it does owe each individual an opportunity to work for his living.

The glee club, under the direction of Charles Toland, gave a rendition of "Dear Land of Home" and "Winter Song." The convocation was adjourned by John Stillwaggon at 11:50 o'clock.

STUDENT ENGINEERING SOCIETIES

The October meeting of the Newark College of Engineering Student Chapter of the American Society of Civil Engineers was held October 14th in room 208C with fifty-three active alumni and honorary members present.

After President Nechwort analyzed our financial status a motion was made and accepted that a special assessment of 50 cents per member would be levied to provide for refreshments after each meeting.

Mr. Dotter, representative to the Metropolitan Conference, announced that a basketball league, consisting of neighboring Student Chapters, was forming. He expressed hope that the Newark Chapter would be represented in this league.

President Nechwort announced that a reunion of the members who had attended Camp Technology would be held in Boston near Thanksgiving time.

President Allan R. Cullimore, President of the Newark College of Engineering and Director of the Newark Technical School, the guest speaker of the evening, chose for his topic "The Civil Engineer in National Defense." President Cullimore, in his address, stressed the point that aerial warfare has increased the importance of the Civil Engineer in defensive measures. He stated that caring for the civil population, during warfare, in matters of sanitation, transportation, and protection from bombs has added to the duties of the civil engineer. He expressed the need for decentralization and flexibility in railroad centers, docks, highways, and bomb shelters. The speaker also pointed out that Civil Engineering training has been proven to be very valuable in political, financial, and other fields not usually thought of as Civil Engineering.

On Monday, October 14th, twenty-three members of the Newark College of Engineering Student Chapter of the American Society of Civil Engineers and four members of the faculty visited the James Baxter Terrace low rent housing development in Newark. Mr. Goodsite led the inspection trip over the large plot, pointing out the various phases of the construction work and the methods employed in the construction of this project. Of special interest to the members of the Chapter were the type of forms, methods employed in placing concrete, steel channel furring partitions, and the compactness and careful planning of this much-needed project.

The November meeting of the Newark College of Engineering Student Chapter of the American Society of Civil Engineers was held on November 4th in room 208C with forty-four present.

Mr. A. F. Eschenfelder, Borough Engineer of the Borough of Glen Ridge, and former head of the Civil Department of the Newark Technical School, gave a talk on "The Duties and Problems of a City Engineer." Mr. Eschenfelder told of the various and varied duties of a town engineer in a suburban town. As borough engineer, superintendent of the water department, and building inspector, the problems of water, light, trees, streets, parks, buildings, street cleaning, snow removal, sewer maintenance, and all important improvements in the Borough fall under the jurisdiction of the borough engineer.

Future meetings will be held on December 2, January 6, February 10, March 3, and April 7.

(Reported by David Donald, Secretary, A.S.C.E.)

The first meeting of the Student Branch Chapter of American Institute of Electrical Engineers was held October 8, 1940. Opening with an explanation of the aims and organization of student branch groups, President Rudolph Dehn appointed the following committeemen for the current year: Program, Mr.

Wellesley Earl; Membership, Mr. Edward Heider; Publicity, Mr. John Teszak; Refreshments, Mr. Stanley Kauklis.

The speaker, Mr. L. F. Parachini, commercial design engineer of the Weston Electrical Instrument Corp., presented an illustrated talk on "The Application of Accessories to the Basic Direct Current Instrument." The lecture demonstrated the methods of using shunts, multipliers, copper oxide rectifiers, thermocouples and photo electric cells to adapt the d.c. meter for measuring current, voltage, resistance, temperature and light intensity.

Mr. Parachini is a 1932 N. C. E. graduate.

The next meeting, held on November 13, 1940, was sponsored by the A. S. M. E. student branch and presented "Wings of Gold," a motion picture prepared by the U. S. Naval Recruiting Station at Floyd Bennett Field.

(Reported by Gifford Van Iderstine, Secretary, A.I.E.E.)

On Wednesday evening, November 13th, Ensign Bernard W. Dunlop of the United States Naval Reserve, stationed at Floyd Bennett Field, with two aides from the service to set up and operate projection equipment, presented several films to a combined group consisting of the student branches of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers in Campbell Hall at the Newark College of Engineering. Total attendance, despite the fact that it was a rainy evening, exceeded 240.

At the meeting preceding the showing of the pictures, Robert Fusner of the A.S.M.E. announced that this year's enrollment has already exceeded 110 and promises to exceed last year's mark of 123.

The films shown were, "Wings of Gold," portraying the air training program of the Navy at Pensacola, the "Gray Armada," having to do with the fleet in action, and one other showing the activities of the submarine arm of the service. All were enthusiastically received, and during the question periods between films and at the conclusion of the show Ensign Dunlop was kept busy.

The next meeting scheduled for the A.S.M.E. will be on December 2, and should have as good a turnout as this meeting had. The speaker will be Mr. Maxwell C. Maxwell, vice-president of the Yale and Towne Manufacturing Company, who will speak on the history and romance of locks in an interesting talk called "Home Defense." His demonstration equipment requires two hours to set up and the same amount of time to dismantle so it is anticipated that this will be an unusually interesting demonstration.

An invitation has been sent to Mr. Ernest Hartford, secretary of the parent society, to attend the meeting. It is hoped that he will be able to do so as he, being a member of the Executive Board, is in a position to best define the aims of the society and the part that students are to eventually have in it.

The meeting will be held in Campbell Hall, will start at 8:00 P. M., and all interested parties are invited to attend.

(Reported by Prof. F. J. Burns, Honorary Chairman, A.S.M.E.)

CIVILIAN DEFENSE

A committee to study Civilian Defense was appointed on September 23, 1940, by Allan R. Cullimore, President of Newark College of Engineering. This Committee consists of Professors Harold N. Cummings, chairman; Albert A. Nims, Harold E. Walter, James M. Robbins, Robert W. Van Houten, and Odd Albert. This Committee under the chairmanship of Professor Harold N. Cummings is investigating the means by which the Staff and facilities of the College may best be organized to aid in the National Defense program should such services be requested by the proper authorities.

NEWARK ENGINEERING COLLEGE ENROLLS FIRST SON OF ALUMNUS

(from *Newark Sunday Call*, October 20, 1940)

John Romano, Newark College of Engineering '29, explains a technical problem to his son, John D. Romano, Newark College of Engineering '44. Young Romano, who has just started his freshman year, is the first son of an alumnus to enroll at the local school.

The first son of an alumnus to enroll at Newark College of Engineering is John Romano of 1007 Coolidge Road, Elizabeth, whose father, John D. Romano, was graduated with the class of 1929. Young Romano has enrolled as a freshman in mechanical engineering.

Mr. Romano entered the college as a junior, following his graduation in 1927 from Newark Technical School's evening course. He was awarded one of the seven Gleason scholarships, made available to young men of character and ability by the will of Herbert P. Gleason, former trustee and treasurer of the college.

What this means, in effect, is that the elder Romano went through the college "the hard way," working during the day and attending classes at night for four years, then taking two additional day years with the aid of part-time jobs provided through the school's "co-operative" system. He has been employed by the Western Electric Company's Kearny works most of the time since his graduation.

The younger Romano was born in 1922, just before his father started at Newark Tech. He attended Thomas Jefferson High School, Elizabeth, and was graduated last June.

"We were all agreed that John should attend the College of Engineering," Mr. Romano said yesterday. "It's near home, and it ranks scholastically with any in the country.

"At first, John was inclined to choose electrical engineering. He was attracted to mechanical because he hopes the college's tie-up with the Civil Aeronautical Authority will give him a chance to break into that branch of the work."

Although John will not be forced to work days and attend school at night, as his father did, he has shown similar enterprise. He has saved enough from odd-job earnings to pay part of his college expenses.

NEWARK COLLEGE OF ENGINEERING HAD LARGEST DELEGATION ATTENDING INTENSIVE COURSE IN AERONAUTICAL ENGINEERING AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY LAST SUMMER

Five graduates of the Newark College of Engineering took the ten weeks intensive course in Aeronautical Engineering given at Massachusetts Institute of Technology, Cambridge, Mass., last summer in connection with the general plan to strengthen National Defense. Applications were taken from engineering graduates all over the country with the purpose of training engineers for key positions in the expanding aviation industry. Of these applicants, a selected group only were taken. The information has been received that Newark College of Engineering had the largest delegation attending this course. Tuition was free.

The five men from Newark College of Engineering who took the course have all been gainfully employed. They are: Jarvis C. Buxton, M.E. 1939, of Livingston, N. J.; James D. Kelly, C.E. 1940, of Irvington, N. J.; and Bernard P. Moser, M.E. 1939, of West New York, N. J., who since have all joined the Lockheed Aircraft Corporation in Burbank, California. Also Sydney I. Goldhammer, C.E. 1939, of Newark, N. J., who since has joined the Consolidated Aircraft Corporation in San Diego, California, and Morris H. Garfunkle, C.E. 1939, of Newark, N. J., who since has joined the Curtiss-Wright Aircraft Corporation of Buffalo, N. Y.

A PRECISION "Q" METER

(Continued from page 11)

Comments by Professor James C. Peet, in charge of Electrical Engineering Department, Newark College of Engineering

This paper by Alfred Heinz follows the best traditions of research of which I know. The author investigates the different methods of measuring capacity, etc., and finds objections to most of the present methods. Then he starts to find the new methods of doing the same things. After trying the new method chosen, he finds it possesses certain limitations and errors, and he commences a study of these errors. By careful study he finds that the error of harmonic content and the error of deviation from constant current are both negligible within the limits of use of the instrument. The meter, as at present arranged, forms a direct method for reading distributed capacitance. It does not, however, read "Q" directly. Four tests are required for this purpose.

I understand from a discussion of the matter with Mr. Heinz that, since the publication of this paper, he has made such improvements in the present equipment that perhaps one of these days another paper may be forthcoming.

HIGHWAYS AND DEFENSE

(Continued from page 6)

future expansion of our highways. Much has been written regarding the super highway of tomorrow. It has been pictured as consisting of four or more two-lane highways paralleling one another but being separated by divisional islands. From the standpoint of the flow of traffic under normal conditions, a design of that type probably would be entirely satisfactory. Before constructing any roads of that design, however, the feasibility of locating two four-lane highways, separated from one another by several miles, if possible, should be investigated. The two highways could be connected at frequent intervals by feeder roads so that in the event that a section of one highway was bombed, traffic could be re-routed over the other highway or merely detoured around the impassable section of the first road. A design of this type would unquestionably provide more flexibility in times of emergency. On the other hand, under normal conditions one of the roads could be used for high-speed traffic and the other for traffic moving at a more normal rate of speed. The writer fully realizes that the questions of the exorbitant cost of right-of-way or the topography may render such a proposal impracticable in certain instances, but there are many other cases where this plan might bear investigating.

These, then, are just a few suggested steps in the solution of the problem of keeping our highways open and traffic moving over them under all conceivable conditions. Every good American, of course, hopes and prays that our nation may be spared the ravages of war. But, should war come to these shores, it must not find us unprepared to defend this country to the best of our ability. It is better to have toiled to produce a workable plan that we may never be called upon to put into operation, than to fail in a time of dire emergency because of our inertia and sense of false security now.

DEFENSE SHELTERS FOR CIVILIANS

(Continued from page 5)

the entire world knows is a very real need, saving the lives of civilians as far as possible. At the present time, total war appears to be killing and maiming more civilians than soldiers.

The air raid shelter problem must be attacked at once, for at the best, months and months will pass before even make-shift protection can be provided.

A real danger in this situation lies in the tendency to "go off at half-cock" in this field as in all other fields of the defense problem.

As the writer sees it, the structural problems are almost matters of routine. We know all the formulas needed for the design of any kind of shelter, and we know the physical characteristics of the available materials. We know *how* to design, but we do not yet know *what* to design.

If we do not find out first whether or not there will be a comparative shortage in steel as compared with concrete, or in both as compared with timber, we may expend our energies on plans and specifications for types that can not be built because material is not available. It may develop that heavy timber construction in regions where "hurricane timber" is stored in vast quantities may be the best solution regionally, whereas reinforced concrete may be indicated for similar reasons in other regions.

A survey, in accordance with the basic engineering principle of assembling the pertinent data and analyzing them before starting the design, is suggested as an obligation of the whole engineering profession. A small committee to guide the survey, with experts for consultation and advice in the many specialized problems such as are indicated above, and with power to make constructive recommendations to the proper authorities, should be able to produce effective results in a very few weeks and thereby save vast sums of money and material that would otherwise be wasted in ill-advised shelter construction.

WHAT OUR READERS SAY

To the Editor:

Opportunity to see occasional copies of Newark Engineering Notes has aroused my interest and I would be greatly obliged if you would place my name upon your regular mailing list.

If copies are still available, I would greatly appreciate receipt of the March, 1940, issue which carried a description of "A Demonstration Model for Rigid Frame Theory."

Thanking you for these favors, I am

Very truly yours,
Franklin Thomas, Chairman,
Division of Engineering,
California Institute of Technology
Pasadena, Calif., July 10, 1940

To the Editor:

We are very anxious to obtain a copy of the following: Newark Engineering Notes 3, No. 2, page 12, 1939. (Article is by Waterfield on Cellophane.)

If there is any charge, we will be glad to take care of that. Please send collect.

Thank you for your co-operation.

Miss A. J. Thoroughgood,
DuPont Technical Library,
E. I. duPont de Nemours & Co.
Wilmington, Del., May 22, 1940

To the Editor:

I have been much interested in reading an article by Mr. H. K. Sels and Mr. R. C. R. Schulze on "The Alternating-Current Network Analyzer of the Public Service Electric and Gas Company" which appeared in the May, 1939, issue of the Engineering Notes.

Is there any chance that additional copies of this number are still available? If so, I would like very much to have a copy. If any reprints were made for the Public Service Company some of these might still be available.

If possible I would like to be on your mailing list to receive the Notes regularly as they frequently contain technical articles of much interest.

Thank you very much.

Very truly yours,
R. W. Warner, Chairman,
Dept. of Electrical Engineering,
University of Texas
Austin, Tex., Aug. 15, 1940

To the Editor:

The article by Prof. Nims, "The General Quadratic, or Conic, Angle and Its Functions," is very interesting and throws a new light on several features pertaining to the ever so fascinating conic sections.

The writer of these lines is somewhat touchy on the subject of angles which he considers to be a collection of arc differentials *in perspective*. (Note, ds/r and the fading away effect as the distance increases!) Prof. Nims, no doubt on good authority, offers two ways leading to the mathematical study of angles (Eq. I and Eq. II) of which two possibilities he chooses the latter. Eq. I fills the previously mentioned requirements, but Eq. II seems to indicate a collection of differential triangles (divided by an area, to be sure). The two formulae do not, save for exceptional values, coincide. Is it necessary or even desirable to labor with two different conceptions of angles and does the second one really have any tangible physical interpretation?

Yours truly,
Lawrence E. Widmark, Chief Engineer,
Star Electric Co.
Bloomfield, N. J., Nov. 8, 1940

To the Editor:

I would like to be on your mailing list to receive your publication.

Very truly yours,
Henry F. LaBrecque
Red Bank, N. J., February 14, 1940.

To the Editor:

Will you please place my name on your mailing list to receive regularly Newark Engineering Notes? I have looked forward to the receiving of my first copy and I was greatly pleased as well as interested in its contents.

Very truly yours,
Charles A. Sereno, '39.
Paterson, N. J. November 28, 1939.

To the Editor:

Kindly include me on your regular mailing list of the Newark Engineering Notes.

I have been receiving the above periodical but not regularly.

Very truly yours,
Vincent A. Culmone, '38.
Clifton, N. J., November 28, 1939.

To the Editor:

I have greatly enjoyed the articles in those copies of Newark Engineering Notes which I have received. Please place my name on your regular mailing list so that I may be sure of receiving all future issues.

If it is at all possible, I would appreciate receiving the earlier copies of Newark Engineering Notes. To date I have Volume 2, Number 6, and Volume 3, Numbers 1 and 2 of the Notes.

Yours truly,
Stephen Balashek
Newark, N. J., January 27, 1940.

To the Editor:

I am very much interested in your periodical, Newark Engineering Notes, and would appreciate it greatly if you would kindly add my name to your mailing list. Could you possibly send me a complete set of the back issues so that I may have the whole set in my files? This would be most helpful.

Thanking you in advance for your courtesy, I am

Very truly yours,
Leopold Scheflan, *Research Chemist*
Pyrene Manufacturing Company
Newark, N. J., March 1, 1940.

To the Editor:

We have received Volume 3, Number 1 of your publication, Newark Engineering Notes, and we would appreciate very much receiving the earlier copies and being put on your mailing list to receive future copies. I am sure that the magazine will be used considerably by our engineering students here at South Dakota State College.

Very truly yours,
H. Dean Stallings, *Librarian*
South Dakota State College
Brookings, S. D., March 1, 1940.

To the Editor:

If Newark Engineering Notes are still being published, I would appreciate receiving a copy.

Please note change of my home address . . .

Very truly yours,
Ellis Rosenthal,
Maiden Form Brassiere Co., Inc.
Bayonne, N. J., February 12, 1940.

To the Editor:

Having read with considerable interest your article on Eccentric Welded Connections, I am anxious to apply this method of attack to one of our problems. I thought perhaps you would be willing to take a few moments of your time to steer our course . . .

Very truly yours,
F. W. Pote, B.S., M.S., *Director of Testing*
Whitehead Metal Products Company, Inc.
Cambridge, Mass., January 29, 1940.

DUKE UNIVERSITY EXPANDS

In accordance with a resolution adopted by the Board of Trustees of Duke University, the Division of Engineering, which was administered as part of Trinity College, was reorganized into the College of Engineering of Duke University. W. H. Hall, Professor of Civil Engineering and Chairman of the Division of Engineering, has been appointed Dean of Engineering. Three curricula in engineering, Civil, Electrical, and Mechanical, are offered. The enrollment, which has been set at a maximum of 225, is now 216. The full time teaching staff consists of four men in each of the Civil and Electrical Engineering Departments, and five men in the Mechanical Engineering Department.

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