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health work.

One area of the world, with a population of a half billion, is "heir in abundance" to just about every disease and health hazard known to man. Malaria attacks three hundred million persons annually.

As for mental health, no country is well provided with needed programs of treatment and prevention. This formidable, yet incomplete, picture of world health today, and world health as WHO envisions it tomorrow. And he can translate it in such simple terms that everybody can understand it."

And Doctor Sebelius with full conviction concludes: "All these men and women of good-will at WHO believe firmly, profoundly, with unshaking faith, this: A world of peace and plenty can come only from

Carl Sebelius comments: "Doctor M. G. Candau, the Director-General of WHO, can, in a matter of minutes, make come alive this whole picture of world health today, and world health as WHO envisions a world whose men, women, and children are healthy, vigorous, and fit. Every human being on this earth has a stake in such a world. We are starting to build that world, but we cannot do it without your help. This is a task that requires your professional contribution, your professional good-will, your professional faith."

NEXT MONTH—PART 2

Through the Centuries:

DENTAL FEES

Part 1

by Kurt Proskauer, D.M.D.

This story is told of a dentist in a fashionable section of New York: After extracting a third molar which had given days and nights of unbearable pain, he was asked by his grateful patient: "How much do I owe you?" The dentist replied: "I'll put it this way: Just give me half of what you would have paid me before the extraction."

This story, however, well invented, will not give the future historian any clear evidence of the fees charged for extracting an impacted third molar around the middle of the twentieth century. It will point out, however, the never-changing behavior of man in pain and distress: he is willing to pay anything for relief from his agony; like Richard III, fallen in battle on Bosworth Field, crying out "A horse! A horse! my kingdom for a horse!" The historian will certainly also recognize our dentist's skill in drawing profit from his experience of human behavior and his knowledge of the human psyche.

We, however, are fortunate in having various sources which tell us what sums were asked by or given to dentists in various centuries and in various countries. We have dental bills, ledgers kept by patients and dentists, and documents in the archives of national societies, as well as an abundant source since the eighteenth century newspaper advertisements of dentists, surgeons, and apothecaries.

It is clear that the fee for dental treatment at any given time and place varies with the cost of living, the purchasing power of money, and the demand and supply, that is, with the relation between the
number of dentists available and the number of persons requiring dental treatment. We must keep in mind that dental treatment before the beginning of the nineteenth century was usually limited to extracting aching teeth, applying medicaments, filing curved front teeth, removing tartar, cleaning teeth, and inserting artificial teeth. But such treatment was available only to the well-to-do and more cultured people in the larger cities, since small cities and villages were visited from time to time only by itinerant dentists, and the need for dental prophylaxis was unknown at that time. Very few people sought dental treatment until they had paid for a long period or suffered from the loss of their teeth. Even then they usually managed to cut without teeth or wore dentures only for esthetic reasons, replacing just the front teeth. Thus the advertisements, even in the first half of the century, nearly always notify the public only of the charge for extraction and artificial dentures. The fee quoted—as we shall see later on—was often accompanied by an explanation or comment: from this we learn about the costs of dental care, and also gain much pertinent information which enables us to draw interesting conclusions as to the development of dentistry and its methods and procedures at particular times and places. Some of these advertisements also give a vivid picture of the social and cultural relations between dentists and the members of their communities, especially the medieval men. Fee fluctuations are connected with social events and even changes within the dental profession itself.

The earliest specified dental fee is one I found in the medical budget of a patrician household in Augsburg, Germany. The head of this household, Behain, recorded on January 23, 1568: "Master Nicholas, the barber surgeon, came to my wife for several days when her cheeks were so badly swollen. I honored him with two pounds, twelve pfennig." The entry closes on a rather apologetic note: "He did not want to take any more."

Other early sources of data on dentists' earnings—

not the fees they received for specific individual treatments—are the household books of princely courts and the budgets of larger cities which employed dental services. These documents show in most cases only the total sums received by court- or city-dentists (a kind of official) as fixed salaries. They were paid either money or agricultural and natural products such as firewood, corn, wine, clothes, and woven material. Besides this fixed salary, court-dentists sometimes also received fees for toothpowders, mouthwashes, and other toilet articles of all sorts, cosmetics and perfumes, and medicines they prescribed and compounded themselves for the princely family.

The kings of France and families consulted physicians, surgeons, and barbers, favoring those among their court-surgeons who specialized in the treatment of the teeth and diseases of the mouth. After the official position of the Opérateur pour les dents du Roi—Operator on the Teeth of the King—was created in 1689 at the court of Louis XIV, the court-dentist was also appointed to the other members of the royal family, and his income thus reached a high figure at times. The first to hold this position—from 1669 to 1674—was the barber to the King, François Le Bert. He received 1,200 livres a year. His duty was "to clean and doct the teeth and furnish the roots and ointments when the king washed his mouth." The barbers of the King, who brushed his hair morning and night, wiped him dry after his bath, and cleansed his teeth, received from 600 to 800 livres a year in 1669, three years before the barber Le Bert became Operator on the Teeth of the King.

That the fee paid to the dentists by the princes must have been very generous can be concluded from a passage in the work of the French surgeon Pierre Dionis, Cours d'opérations de chirurgie, published in Brussels in 1708: "The instruments for cleaning the teeth are usually made of steel, but those used on the king and princes are of gold. If there was a more precious metal, the dentist would use it, because they are so magnificently rewarded." The salaries crowding is still the rule for most of the world's one billion children. Almost 80 per cent of the world's population does not have a reliable water supply. They live with fouled rivers, polluted springs, dirty canals, infected wells. In India alone it is estimated that water-borne diseases every year sicken fifty million persons and kill two million.

Fifty million people in the tropics suffer from yaws, which is caused by a spirochaete similar to that of syphilis. About eight million are lepers.

Another country, with a population of three and a half million, has only six persons trained in public
allowed to royal dentists were indeed very high. The practice of King Louis XIV’s dentist, Dubois-Guerin, who held the position from 1670 until 1708, is estimated to have brought him 5,393 livres a year, an enormous sum for that time.

There are some interesting items on dental care in the accounts of the French King Henry IV: in 1576, exactly one hundred years before Dubois-Guerin became dentist to Louis XIV, he spent twenty sous a month for toothpicks, and in 181 for “gold to fill the teeth of the king 15 livres, 15 sols,” a livre being about equal to our present 20 cents, divided into 10 sols or sous.

For the year 1789 we have documentary evidence of specific fees paid by Louis XVI to the Parisian dentist Etienne Bouderet, who was dentist to the royal household and served not only the ill-fated King and Queen Marie Antoinette, guillotined in January 1793, but also the King’s brothers, the future Kings Charles X and Louis XVIII; the King’s sister, Elizabeth; and the King’s two sons, the young Louis Joseph and the future Louis XVI. In 1789, the year of the outbreak of the French Revolution with the storming of the Bastille, Bouderet received the following sums for his dental work on these members of the royal family:

- Reimbursement of expenses during his voyages in the retinue of the king: 3,500 Livres
- Reimbursement for travelling-expenses in connection with treatment of the king and the royal family: 2,000 Livres
- Services rendered to the Queen (Marie Antoinette):
  - Reimbursement for his absence from Paris: 2,000 Livres

In 1815 the famous Italian inventor of single porcelain teeth, Giuseppeangelo Fonzi, was called to Munich by the King of Bavaria, as Guerini reports in his Life and Works of Giuseppeangelo Fonzi. He was assigned an apartment in the royal palace and lodged and boarded there for four months; during this time he treated the King and royal family and other great personages, to the complete satisfaction of all. Besides his large pecuniary compensations, he received magnificent presents and also had the honor of being appointed dentist to the King of Bavaria. After 1816 Fonzi was twice “called to Madrid by the King of

THE HAPPY DENTIST

Notice that I’m bright and gay,
Jovial in the things I say,
Haven’t got a single gripe?
Think I’m a peculiar type?
Mark me that I seem to be
Easy-going, calm and free,
Never nervous, quick, or short?
Figure I’m a funny sort?
You other dentists round-about now,
Harrassed-looking, scrape and bow,
Wait for patients for your chair
With a faintly eager air—

You other dentists mail out bills,
Start to taking your own pills,
Scan your patients’ pocketbooks
With some hopeful, anxious looks—

I’m the one who can pick up
The check for coffee in a cup
I’m the fellow full of cheer
Although middle April’s here!

All you men with profits high,
Look at me, and don’t think I
am not enjoying—while I can—
Being a lower-income man!

Helen Harrington
Spain, whom he treated with great success, thus obtaining still more renown, not to speak of the material profits derived from the regal munificence. In 1825 Fonzi went to Russia, where he stayed about two years. He had been named Surgeon-Dentist to the Imperial Court. The Queen "was so satisfied with Fonzi's work that she continually made him presents of great value.

In the summer of 1825 Fonzi was called to Madrid for the third time by the King of Spain. A special courier accompanied him to Spain at the King's expense, and at the frontier a military escort, by order of the King, awaited him and accompanied him to Madrid, where an apartment in the royal palace was placed at his disposal. He remained in Madrid about seven months. The King much satisfied with his services, named him Dentist to the Court and conferred on him a pension of 1,000 ducats per annum, a very considerable sum for those days, "approximately $2,800," as Brenner says, "but the equivalent of six or seven times as much in present day purchasing value."

Researching a New Speech Aid

Research under way at Northwestern University's Cleft Lip and Palate Institute may result in a new speech aid not only for cleft palate patients but for bulbar poliomyelitis patients as well. Designed by Doctor Morton Rosen, assistant professor of prothetic dentistry, the appliance, much like a dental plate or bridge, has been used successfully on bulbar poliomyelitis patients.

These patients are often left with a speech defect sounding like that of the cleft palate victim. The reason for this is that those with bulbar poliomyelitis often have a paralyzed palate and are no longer able to keep air from going up through the nose. Once they have recovered from the acute state, the victims' greatest residual defect may be the speech impairment. Because the soft palate is paralyzed, the sound goes through the nasal cavity and the voice then has a nasal sound just as in persons with cleft palates.

The prosthetic appliance, which is a modification of the one designed for cleft palate patients, covers the soft palate and blocks off the nasal cavity. It is attached to the teeth much like any other dental prosthesis.

According to Doctor Rosen, this represents an important step forward in the treatment of bulbar polio patients who have been left with a speech defect. He emphasized that with the appliance there is some immediate benefit but that it must be supplemented with speech therapy.

A new dental device that photographs all of a patient's teeth in one exposure has undergone tests at Lackland Air Force Base, Texas. The device, called the panoramic X-ray machine, was developed by the dental section of the National Bureau of Standards, with the cooperation of the Air Force Dental Service, and the School of Aviation Medicine at Randolph Air Force Base, Texas.

Its principal inventor is John W. Kumpola of the Washington, D.C. agency. He assisted Lt. Col. Russell Butler, head of the Lackland Dental Processing Section, in testing the instrument on Air Force trainees.

The machine differs from the usual dental photographic equipment in that a film holder and the X-ray source, mounted on opposite ends of a thick, metal arm, travel in an arc around the patient's head. The film, moving in front of the subject, is exposed when X-rays pass through the back of the head.

Thus, in a matter of seconds, a complete picture of a patient's dentures is available to the dentist. Heretofore, a skilled dental technician, working with standard equipment, took twenty minutes to perform the same task.

A predental student who became interested in the mechanical aspects of the field, Kumpola began work on the panoramic X-ray machine in late 1954. For a time, the Air Force officer in charge of the project, Col. Donald C. Hudson, now chief of the Research Dentistry Division at the School of Aviation Medicine, aided in the early stages of the machine's construction. Kumpola expects to have the machine ready sometime this year for wider use among the armed forces.
What are the early qualities which go to make up a woman dentist?

What impelling force early in life so captures her imagination that she willingly turns aside from the usual feminine activities, and makes the big decision to join the ranks with the men in the long arduous years of dental preparation?

Most amazing of all is the curiosity which can keep a woman dentist dedicated to her profession all through her life, with not even marriage and home interests turning her from her career. These questions were answered for me the other day when Doctor Hazel Merrick and I had a stimulating two-hour visit, during which I fired questions and she fired interesting answers right back at me.

Doctor Merrick—who is so femininely attractive that "Hazel" suits her more than the formal "Doctor Merrick"—was one of two girls in my husband's dental class at the University of Southern California. She loved dentistry then, and she loves it today. She was the wife of a prominent dentist, Doctor David McLean, until his death a few years ago. At one time she lived in Arcadia, near Los Angeles, and Doctor Merrick still has her office there.

Not only is she her grandmother's dentist, but also her father, her uncle's, his brother, and a nephew. The family hoped she would be able to carry on the tradition, so her dentistry was charted in advance.

In 1927 she was appointed chief dentist with twelve dentists and five dental hygienists under her super-

vision. She weathered the depression, with its serious budget cuts in her department, by putting everyone on half-time service, determined not to part with her valued personnel nor to imperil the important dental work with children which she had built up so carefully.

The attention these men are giving this phase of their practices also applies to dentists in other parts of the country, as evidenced by the recent comments of a Florida specialist. His work is limited to prosthodontics, which requires that he see fewer patients than dentists in general practice. Nevertheless, he says, "I have always felt it is just as important for the dentist to be punctual for appointments as it is to expect the same of patients. A mutual respect for each other's time is essential in building and maintaining a successful practice."

This reference to mutual respect has been echoed in the remarks of dentists in New York, Ohio, Virginia, and Illinois, with each insisting that the efforts made in dental offices to get patients to arrive on time is more successful when the dentist operates on an exact schedule. A Wilmington, Delaware, dentist, deciding to break up his routine by giving a half-hour after his office closed each morning and afternoon, this procedure followed: "I had a man who left his job just down the hall arrived fifteen minutes late for a mid-afternoon appointment. He called and said you ready for me," the office manager explained. "The last two times I spent ten to twenty minutes reading your magazine."

In the practice of Doctor William S. Miles, Jr., of Glenside, Pennsylvania, such happenings are held to a minimum, since he has set aside a "buffer" period each morning and afternoon. This procedure follows a pattern similar to that of Doctor Allyn S. Abramson of Los Angeles, in that both men allow a half hour from ten-thirty to eleven and from three to three-thirty to "catch up" when earlier appointments are held. The hour each day, however, is by no means non-productive, since, as Doctor Abramson explains, it can be devoted to emergency cases, laboratory work, or preparing for future patients. Also, with the consent of the patient in the chair at ten-thirty or three, the appointment may be lengthened if there is no other demand for the dentist's attention during the "buffer" half hour. Doctor Miles, who practices in a suburban area, has given this subject of timing considerable thought and in making an appointment he does not limit his in-


Don't Keep Patients Waiting:

Two dentists, one in California and the other in Pennsylvania, although separated by nearly three thousand miles, have arrived at nearly identical solu-

tions to the problem of meeting the appointments of patients "on the dot" so as not to disrupt the social and business lives of those three—women, men, and working teenagers.

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structions to the arrival time but also mentions how long he expects to keep his patient in the chair. "In this way," Doctor Miles points out, "a patient is left free to schedule business or social appointments with assurance that he will be in a position to keep them. On occasions when he runs into some unanticipated problem that delays his operations, it is Doctor Miles' practice to telephone the patient who has the next appointment and explain that he will be delayed. If the delay does not interfere with that patient's plans, he is free to come in as scheduled, or otherwise another period is arranged."

This emphasis that so many dentists are now placing on accurate scheduling of patient arrival and duration is closely linked with the current high employment figure. While this same condition has contributed to a stepped-up demand for dental services, it has also added a dollar importance to den-
tal chair time entirely unrelated to professional fees. In many homes both the father and the mother are employed and even the teenage chil-
dren are likely to have part-time, after-school jobs. Except for those working in executive positions, time lost from the job means a reduction in income and even among the self-employed and others who are "on their own," time is measured in dollars and cents. Thus we have a trend consid-
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and with less possibility of complaints from time-conscious patients.

Among those dentists who have succeeded in adding a higher degree of exactness to their appointments several admit that the task was simplified by first searching out the root of the problem. As a Philadelphia dentist explained, "I had to learn to say no when asked to add a patient into a schedule already crowded with my physical and professional capacities." This seems like a simple accomplishment until it is recalled that veterans and newcomers to the field fall into the habit of accepting too many patients for understandable reasons. The older man may have had periods when calls from patients were so infrequent that his appointment book had a discouraging number of blank spaces. He has never forgotten over the desire to keep that book filled to capacity, so he takes on more than he can handle with satisfaction to himself and his patients. The younger man on the other hand, in his anxiousness to create many patients for understandable reasons. The older man, the numbers of blank spaces. He has never

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Figure 9. Cross-linking of linear molecules, complete and partial.

SPRING EXERCISE

Oh, wife, dear wife, you know it's spring,
The time is almost here—
Look up my hiking shoes; and bring
Forth all my fishing gear!

Put out my hook on birds, and my
Binoculars go find.
You're beautiful. You satisfy,
You understand. You're kind.

The grass is tall? (Can't win!)

Lawn mower? Oh. And can't I see
The grass is tall? (Can't win!)

Confound! I'm tired! Besides, praise be!
Here's a patient coming in!

THINGS TO DO

For years I had been plagued by slipping cotton rolls when placed on the lingual side of molars and the buccal area of the lower. I used clamps but they were uncomfortable to the patient. I happened to remember the stickiness of a denture powder that I used quite often. I sprinkled some of the powder on a cotton roll and put the roll in place. It stayed right where I put it, saliva had no effect on it, and it did not loosen.

After I have polished out the scratches and the washboards of acrylic dentures to give the finished work a high polish, I make a rather stiff paste of whitening glycerine. I then use a soft rag wheel brush on my lathe which has had the paste rubbed into it. This gives the denture the high polish everyone likes to see. The excess paste left after polishing can be washed away quickly by holding the denture under the cold water faucet.

To amuse my small-fry patients I make whistles for them from empty anesthetic carpules. The tone of each one depends on how far down in the glass the stopper is pushed. By blowing across the top, the whistle sounds. I set the carpules in soft plaster (rather my assistant does) so that no younger can accidently swallow one. They are set in a series of six different tones, from low to high.

R. B. M.
they have similar polymerization characteristics as regards catalysts, temperature, and time.

In Figure 6 we illustrate some of the possibilities of co-polymerization of monomers A and B as illustrated in Figure 5. A may chain only with A, and B may chain only with B. Chains may form according to some regular pattern such as A-B/A-A-B, or AAA-BBB, or B-A-B-B-A-B-B, or almost any conceivable arrangement depending upon the percentages of A and B, with a certain number of uncombined molecules of each constituent. Co-polymerization, while attractive in theory, often fails to work out in practice, since some monomers prove to be mutual inhibitors when mixed, or one monomer may polymerize, and the other fail to do so. Our efforts to impart some of the good properties of each resin often result in a “gunk” having the good properties of neither of its constituents.

Cross-Linked or Tridimensional Polymers

For the most part we have limited our discussion to linear polymerization, with a brief reference in the cases of condensation and vulcanization to polymerization of three-dimensional molecules. There are, however, numerous organic compounds which undergo true polymerization to form molecules which grow in three dimensions. The resulting polymers are insoluble and infusible. They can be destroyed by heat or by chemicals, but cannot be rendered workable by heat or chemicals used alone or in combination. Most of the true tridimensional polymers have no industrial value in the pure state, for they are weak and brittle. They are not suited to casting since the polymer is not soluble in the monomer, and hence they are lacking in gel-strength. Some of these monomers are used as co-polymers to form “cross-linked” resins where they contribute some measure of heat- and solvent-resistance. The value of these cross-linkers in denture base may be questioned, but their value in plastic teeth has been demonstrated. Here we have constructed cross-linking molecules by connecting the receptor ends of two Popperit beads, and by drilling them laterally we have added four receptors.

Cross-linking monomer molecules.

In Figure 7 a number of the molecules as shown in Figure 8 have been snapped together to form a space model having length, breadth, and height. A large space model constructed in this manner would lack the adaptability of an equal number of beads grouped in long or short chains. Its response to deforming stresses would tend to brittle fragmentation rather than the breaking of some chains and displacing of others as would be the case if the mass consisted of a myriad of linear chains.

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In Figure 9 we attempt to illustrate a possible cross-linking of a straight chain polymer with a polymeric-sulfur cross-link such as ethylene glycol dimethacrylate.

Figure 6. Several types of co-polymer chains.

Figure 7. Cross-linking monomer molecules.

Figure 8. Tridimensional molecules.

Dental Thusa and Data

Research in the transplantation of teeth is being carried out in Michigan by Doctor James K. Avery. Although still in the experimental stage, they plan to establish "tooth banks" throughout Michigan and have oral surgeons operate the banks in their areas. It sounds plausible as far as the oral surgeons are concerned—no other dentists are more familiar with withdrawals. Of the fifteen prize hints chosen by the Homemakers Forum of the United States and Canada, at least two might have been dreamed up by some dentist or dental assistant. For example, one of the hints suggests the use of dental floss instead of cotton thread in sewing buttons on garments that keep loosening or coming off. The other suggestion might have some merit even in a dental practice—with some variations. It suggests the use of lollipops as tongue depressors when looking into a small child's mouth. There's little doubt that a clear view of the mouth and throat can be obtained in this manner without any strenuous objection from the child, especially if you sort of move the lollipop around a bit over the tongue. Some sugary lollipops might be handy in the dental office as cheek retractors for the little one instead of so surgical looking an instrument as a shiny mirror.

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Human Relations

For a good short course on human relations the following from the Watertown News and Views packs a lot of sense:

1. Five Most Important Words: I AM PROUD OF YOU!
2. Four Most Important Words: WHAT IS YOUR OPINION?
3. Three Most Important Words: IF YOU PLEASE!
4. Two Most Important Words: THANK YOU!
5. Least Important Word: I

Incidentals

Usually, in comparing dental fees of past years, we find that today's fees are the highest. However, a British dentist, Doctor Martin Van Butchell, got $500 for a set of dentures back in 1830. . . . The most useless bit of information we received in our mail recently comes from a large concern's periodic bulletin: "One or two injections of iminodipropionitrite will cause mice to run continuously for the rest of their lives, except when they eat or sleep."

Quotes and Queries

One of the popular periodicals noted this interesting sign in a doctor's waiting room: "Ladies in the Waiting Room Will Please Not Exchange Symptoms. It Gets the Doctor Hopelessly Confused. . . . Grammatically speaking, split infinitives are frowned upon but split sentences can cause quite a chuckle. Just the other day a dentist showed me the following note from a parent who wished to give permission for an extraction for her child under nitrous oxide. Said the note, 'You have permission to take my son's tooth out. He was up all night, with gas.' . . . Have you heard about the rich Texan who has a different dentist for every tooth?"
An acrylic resin, methyl methacrylate, was introduced as a denture base in the latter part of the Nineteen Thirties, and with it was introduced to dental science "polymerization." The curing or processing of rubber was called vulcanization and the curing of the phenolic resins was termed condensation. The curing of the acrylic resins, however, is polymerization.

The visible result in each case is the same: a soft material is converted to a much harder state by heating under pressure. The changes effected in the molecular structure bear a superficial resemblance. In vulcanization, a new grouping of rubber molecules is effected by the reduction of sulfur to sulfides, with changes in the atomic structure of the rubber molecule. In the type of curing known as condensation, a polymeric type of molecule is formed by the uniting of two different molecules. At the same time, some atoms are eliminated by combining in a simpler or more similar molecules in which the atoms remain in similar relative positions. The three-dimensional molecule formed grows in three dimensions, length, breadth, and height. The three-dimensional polymer, however, is not peculiar to vulcanization or condensation.

Polymerization may be defined as "a union of two or more similar molecules in which the atoms remain in similar relative positions" (Hackh's Chemical Dictionary) and: "The new molecular weight is a multiple of that of the original compound. From the polymer, the original substance may or may not be regenerated." The macromolecule may grow in one dimension as a linear molecule, or it may be a complex molecule of three dimensions. Either the linear molecule forming the thermoplastic resin, or the three-dimensional molecule of the thermoset resin may be formed as a result of true polymerization, depending upon monomer used.

No one has seen a molecule; it is probable that the molecule does not exist as a tangible object. We can leave its spatial existence to the theorists, for the molecule behaves like an object having a discreet form, and in order to diagram its behavior in certain cases, we will for the purposes of this discussion assign it physical form and substance. Circumstantial evidence exists that the linear molecule of a thermoplastic polymer has a filamentous form, and that its resistance to stresses and solvents is directly related to the number of monomer units composing it.

For the purposes of illustration we can also consider the methacrylate monomer molecule as having a "head and tail," and the molecules link head to tail during polymerization. This view is not wholly accepted by the theorists, but it will serve our present purposes. The statement will also be made that each chain whether long or short will have one, perhaps two ends which are vulnerable to solvents and to other destructive forces, and the greater the number of ends, as in short chains (lower molecular weight polymers) the greater the vulnerability of the polymer to agents which cause changes in the material.

In order to visualize polymerization we can use diagrams, drawing hypothetical molecules, or structural formulae, where the monomer molecule is illustrated combining carbon to carbon.

For the present article, Poplett beads were used. These beads, made of polyethylene, can be bought at almost any novelty counter. Red beads (in the photographs) were selected to represent methyl methacrylate monomer and polymer. White beads represent a co-monomer, compatible with methyl methacrylate, and some large pellets of vinyl acetate represent any impurity which does not attack the monomer molecule and does not enter into the polymer chains, such as an organic plasticizer. Holes were drilled in the sides of the beads since these beads were to be used to illustrate the phenomenon of cross linking.

Figure 1. Monomer molecules.

In Figure 1, the detached individual beads represent monomer molecules. If we disregard the side holes, it will be noted that each has a positive and negative end, a projection and an orifice which will receive and hold the projection of another bead. An infinite number of them can be joined in this manner to form a chain. A great many of these unconnected beads in a container would exhibit some of the characteristics of a liquid.

Figure 2. Long chain polymer.

In Figure 2, sixty of the beads are joined together into a single chain representing a polymer molecule. The mobility of the group is no longer that of a liquid. The weight of our new unit, the chain, will be sixty times the weight of the individual bead.

Figure 3. Monomer with plasticizer.

Figure 3 represents a methyl methacrylate monomer to which a quantity of plasticizer has been added. The plasticizer molecule does not possess the type of bond that will allow it to enter into polymers either with the methyl methacrylate or with itself. The large irregular clear beads representing plasticizer are scattered at random among the monomer molecules. It is dissolved in the mass of monomer, but the individual molecules are not in chemical or physical combination with those of the monomer.

Short polymer chains and plasticizer molecules, monomer containing plasticizer or other inert matter when subjected to certain influences such as heat and catalysts will polymerize, and macromolecules will form until most of the monomers have either become parts of chains, or until chain growth is halted by encountering other growing chains or some inert obstructing molecules. Plasticizers are added to monomers to render the polymers softer, more easily moldable in compression or injection molding.

Co-Polymers

Co-polymerization can result when two or more compatible monomers are mixed and the mixture is subjected to conditions necessary for polymerization. The subject of co-polymerization is a complex one, and beyond the scope of this discussion. Co-polymers are not mixtures of two or more preformed polymers, but the result of the action of a monomer on a pre-formed polymer.

Figure 4. Plasticized polymer. Interrupted chains.

In Figure 4, the mixture of two monomers, dark beads A, light beads B, represent any impurity which does not attack the monomer molecule and does not enter into the polymer chains, such as an organic plasticizer. Holes were drilled in the sides of the beads since these beads were to be used to illustrate the phenomenon of cross linking.

Figure 5. Mixtures of two monomers: dark beads A, light beads B.

In Figure 5 we have mixed light colored beads and dark colored beads of differing sizes representing monomer A and monomer B. We will assume that each of these monomers is a methacrylate ester and hence related chemically, also we will assume that

Weights of as high as 1,000,000 are specified in the basic materials from which some of the better denture bases are compounded.