Jan. 12, 1943. H. S. TAYLOR 2,308,402

CONSTRUCTION OF MOLECULAR MODELS

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Fig. 1.

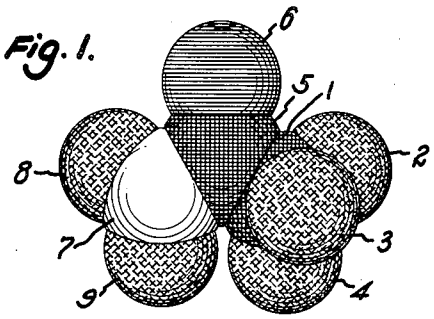


Fig. 2.

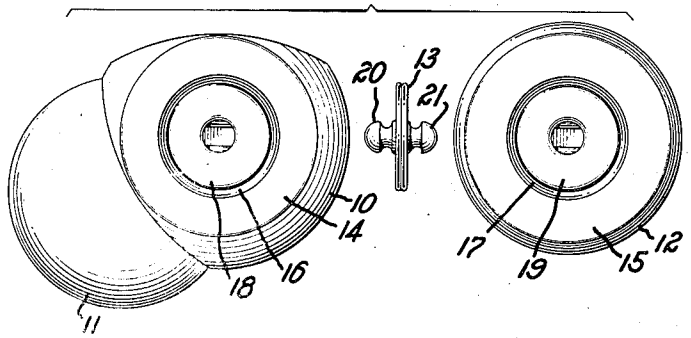


Fig. 3.

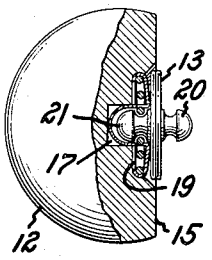


Fig. 4.

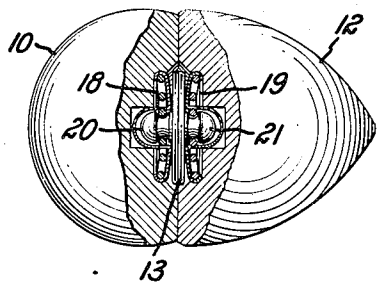
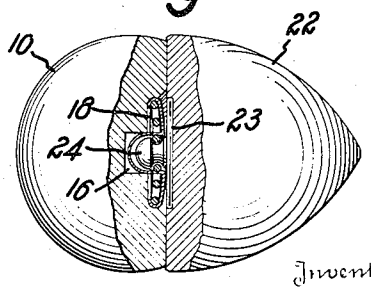


Fig. 5.



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UNITED STATES PATENT OFFICE

2,308,402

CONSTRUCTION OF MOLECULAR MODELS

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5 Claims. (Cl. 35—18)

This invention relates to the construction of models—e. g., models of molecules—composed of a plurality of unit pieces, e. g., "atomic units," detachably secured together in assemblages of desired configurations, and is particularly concerned with the provision of improved means for attaching the unit pieces one to another in such a way as to give a stronger and more positive mode of attachment while at the same time securing a greater flexibility of motion in such attachments. More particularly, the invention relates to the production of molecular models by the suitable attachment, one to another, of pluralities of models of atomic units whereby to produce assemblages reproducing model molecular configurations, and having, by reason of the method of attachment of the atom models herewith provided, a greater manipulative stability, together with a flexibility of motion more closely corresponding to the behavior of the structures modelled, than have the molecular models heretofore known and used. The invention is peculiarly applicable to the construction of molecular models for use in the study of chemistry and physics; however, it is not limited thereto but is applicable also to any other models or toys where the same characteristics of stability and flexibility are desirable.

Atom models with which model molecules having the closest structural resemblances to actual molecules can be built have already been proposed. Such models have found considerable scientific application and possess considerable educational and instructional value. As constructed hitherto, the units are assembled and held together by the use of stout wire connectors or, as in a more recent improved form, by the use of double-tapered pegs fitting into depressions formed therefor in the atom models. The atom models in this latter case are provided with "bonds" (this expression being here used not only in the scientific but also in the mechanical sense) which may be single, double or triple, formed by inserting the pegs (one, two or more) in appropriate holes (one, two or more in number) in the appropriate faces of the atom models. In the case of the doubly and triply bonded atoms this mode of tapered-peg connection has been found to be more satisfactory than the single tapered peg connection, since, in the nature of things, the bonds so formed are rigid and motion at such bonds normally is not required in molecular models.

In the prior art construction just referred to, a single bond is secured by insertion of a double-tapered peg in the holes in the centers of opposed faces of two atoms to be attached. Some rotation of the two atoms around the tapered peg in the single bond connection—as is necessary for the close imitation of actual molecules by the models—is thus possible. It has been found, however, in actual practice, that while freedom of rotation about the single peg is thus possible, the "atomic" parts are not positively secured together (so long as there is substantial freedom in the fit of the peg in the holes), and hence that the stability of the model under manipulation is of a low order. Especially in the case of structures or assemblages possessing a large number of singly bonded constituent model atomic units there is a great tendency for the completed models to fall apart into fragments when manipulation (by rotation of the constituent parts, one with respect to another) of the models is attempted. The present invention provides a simple and ready method of overcoming this disadvantage.

It is an object of the present invention to provide atomic units which may be connected together by single bonds to produce molecular model assemblages wherein the attachments are positive (in the sense that the parts are locked together against accidental rupture of the models) while at the same time are permissive of full and free rotation between singly bonded atoms. Another object of the invention is the provision of model atomic units which are susceptible of ready separation from each other but which, while attached together in molecular assemblages capable of full rotation at all single bonds, are positively locked against accidental "disruption" of the "molecules."

According to the present invention the above, and other, inventive objects are attained by providing each model atomic unit, having at least one plane face, with an element of the well-known two-element snap fastener of the rigid head-resilient socket type at or in said plane face, which element shall function, either (1) by direct cooperation with the other element of the snap fastener at or in a plane face of a second model atomic unit or (2) through a connecting member including the other element of the snap fastener, detachably to secure together two such model atomic units at said plane faces thereof. Thus, in one embodiment *a* of the invention, the resilient socket element of a two-element snap-fastener of the rigid head-resilient socket type may be permanently secured within a depression in a plane face of one model atomic unit and the rigid head element of such fastener combination

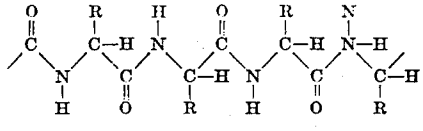
permanently secured at a plane face of another model atomic unit, the depth of the depression in which the socket element is secured being such that when the two elements of the snap fastener are secured together the two model atomic units are brought substantially into face-to-face contact. Or, in another embodiment *b* of the invention, the model atomic units may be provided with the aforesaid resilient socket elements (permanently secured within depressions in the plane faces of such units), and there may be employed as connecting members double-studded elements, each of which latter consists either (1) of two rigid head elements (of the snap fastener) permanently secured to each other back-to-back or (2) of a functional equivalent of such a combination. Embodiment *b* is preferred for—among others—the reason that it does not restrict the user in the choice of model atomic units (from a collection, or arbitrary number, thereof) for construction of the desired model, whereas in embodiment *a* the slight economy in number of snap fasteners employed per each pair of model atomic units is usually more than offset by the cost of the larger number of the units made necessary by the diversity of securing means.

The specific mode of securing the snap fastener element to, or in, the plane face of the model atomic unit is a matter of choice and is not critical within the scope of the invention. Where the model atomic unit per se is formed from a plastic material (e. g., a thermo-setting, or thermo-plastic, resin composition) the socket element conveniently may be embedded in the unit during the course of formation of the latter. Where the unit is formed from wood, a depression the size of the socket element may be bored in the plane face of the unit and the socket element driven into the depression; or, the socket element may be glued or nailed or otherwise permanently attached within the depression.

The double-studded connecting member may be produced by soldering (or welding or brazing or otherwise permanently attaching) two preformed rigid head elements back-to-back; or, it may be produced directly by suitable modification of the existing method of manufacture of such rigid head element.

The securing means hereinbefore described provides a most satisfactory "single bond" between unit atomic models. Molecular models, containing scores or hundreds of model atomic units, of great configurational complexity thereby can readily be constructed, which complicated molecular models have a high degree of stability against accidental breakdown during manipulation and at the same time permit of that free and full rotation of the parts thereof about the single bonds which represents a primary desirable characteristic of such models.

As a typical example of the molecular model which can advantageously be constructed with the snap fastener binding of the individual atom units, a polypeptide chain of the general structural formula



may be cited. This is a two-dimensional representation of a three-dimensional unit made up from model atoms now commercially available but modified in accordance with the present invention in such a way that each single bond, indicated by a single line in the two-dimensional formula, is constructed from portions of the snap fasteners as already outlined above. Models so constructed can successfully be employed to study the foldings which are possible in flexible chains of atoms of this type. As typical of other molecular structures that have been constructed from model atomic units provided with the above-described securing means, large molecular models representative of the vitamins, hormones, sterols, medicinals, the plastics, synthetic rubbers, carbohydrates and starches, as well as smaller and simpler molecular assemblages, may be cited. These depend for their success on the effectiveness of the new snap fastener linkages serving as single bonds between model atomic units. The scientific and educational advantages of the resulting structures are, therefore, evident, as is their value as educational toys for children of school age.

For younger children structures from units of various geometric, or grotesque, or other arbitrary, shapes similarly joined by snap fasteners can readily be conceived from the foregoing description.

The invention will now be described in greater detail and with reference to the accompanying drawing, in which

Fig. 1 illustrates an assemblage of model atomic units, representative of the model of acetamide, embodying the invention;

Fig. 2 is an expanded plan and elevational view of mating model atomic units;

Fig. 3 is a sectional elevational view of a model atomic unit showing a double-studded connector detachably secured to a model atomic unit;

Fig. 4 is a sectional elevational view of two model atomic units secured together by the preferred connecting means of the invention; and

Fig. 5 is a modification of the showing in Fig. 4 and illustrates an alternative connecting means within the invention.

In Fig. 1, the chemical identities of the various "atoms" constituting the acetamide "molecule" are represented by appropriate shading, the carbon atoms **1**, **5** being shown as black, the nitrogen atom **7** as white, the oxygen atom **6** as blue and the hydrogen atoms **2**, **3**, **4**, **8** and **9** as orange. It will, of course, be understood that the various elements may be represented in any other arbitrary manner (e. g., as by imprinting the chemical symbols C, N, O and H over the curved surfaces of the respective model atomic units).

If desired, double bonds between adjacent atoms may be formed by providing a pair of connecting means between such atoms: in this case, rotation between atoms would be prevented. For instance, in the assemblage of Fig. 1, the oxygen atom may be attached to the adjacent carbon atom by a pair of double-tapered pegs as hereinbefore described.

In the assemblage illustrated in Fig. 1, each of the hydrogen atoms **2**, **3**, **4**, **8** and **9** has a single plane face and a single connection; the carbon atom **4** has four plane faces and four connections; the carbon atom **5** has three plane faces for two single bonds and one double bond; the oxygen atom has one plane face for one double bond; and the nitrogen atom **7** has three plane faces for three single bonds.

The possibility of rotation between various parts of the model (e. g., between the two carbon atoms; between the amino group and the adjacent carbon atom; etc.) can be demonstrated

without danger of disruption of the molecule; moreover, the molecule is susceptible of ready metamorphosis by the substitution of other parts for parts present in the acetamide molecule. Thus, the methyl group 1, 2, 3, 4 may be snapped off of the carbon atom 5 and be replaced by another appropriate atom or by a sub-assembly of joined atoms representative of, say, an ethyl or propyl or other appropriate monovalent group. Similarly, the amino group 7, 8, 9 may be snapped off of the carbon atom 5 and be replaced by another appropriate monovalent group or by an appropriate single atom.

Figs. 2, 3 and 4 illustrate the preferred combination of model atomic units and connecting means. Fig. 2 shows two joined atomic units 10 and 11, a third atomic unit 12 and a connector 13 for joining atomic unit 12 to atomic unit 10. In the plane faces 14, 15 of units 10 and 12 are depressions 16, 17 in which are permanently secured socket elements 18, 19 of the known snap fastener of the head-and-socket type. Connector 13 has oppositely disposed heads 20, 21 either of which is mateable either with socket 18 or socket 19. Units 10 and 12 may be joined by engaging head 20 (or 21) of connector 13 in socket 18 (or 19) and engaging the opposite head of said connector in socket 19 (or 18), thereby providing a fully rotatable combination in which the parts are locked together against accidental disruption while enjoying a desirable flexibility and being readily separable at the will of the demonstrator. According to Fig. 3, the head 21 of connector 13 is shown engaged in socket 19 of atomic unit 12, and in Fig. 4 the atomic units 10 and 12 are shown joined together by engagement of heads 20, 21 of connector 13 in the sockets 18 and 19 permanently secured in the respective atomic units.

According to the alternative embodiment illustrated in Fig. 5, atomic unit 22 carries, permanently secured thereon, the male half 23 of a snap fastener of the head-and-socket type whose head is engageable in socket 18 of atomic unit 10 for joining atomic unit 22 to the latter by a readily severable single bond permitting rotation between the units while locking them together against accidental disruption of the combination.

While in the foregoing specific description it has been stated that the bonds preferably are carried at substantially plane faces of the model atomic units, it is within the scope of the invention to secure the fastening elements at any desired points on surfaces of the atomic units.

Moreover, it is to be understood that while the snap-fastener preferably is of the rigid head-resilient socket type it is within the scope of the invention to employ for this purpose any of the existing types of head-and-socket snap fasteners: also, that while it is preferred to have the socket elements permanently secured to the atomic units and to couple by means of a double-headed connector it is within the scope of the invention to secure the head elements to the atomic units and to couple by means of a double-socket connecting member.

It is within the purview of the invention to connect two (or more) atomic units by means of a plurality of the snap fasteners representing double, or triple, bonds between adjacent atoms. In such event, it is advantageous to form the plural snap fastening elements on an integral plate, for positive and accurate alignment of the fastening elements. This arrangement ensures the positive locking of a double, or triple, bond against accidental disruption of the "molecule."

I claim:

1. A set of model atomic units adapted for use in building a three-dimensional model of a molecule, comprising a plurality of rigid members each representative of an atomic unit each of which rigid members carries at least one element of a two-element snap fastener of the head-and-socket type rigidly and permanently secured to said member and adapted to interlock with a mating fastener member carried by another like rigid member, and at least one rigid member representative of an atomic unit having rigidly and permanently secured thereto a plurality of such fastening elements in spaced relation to permit attachment thereto of a plurality of similar or dissimilar rigid members, whereby there may be formed a molecular model permitting full rotation about single bonds between adjacent rigid members while maintaining said members securely fastened against accidental separation and with surfaces of adjacent rigid members in contact with each other.

2. A set of model atomic units adapted for use in building a three-dimensional model of a molecule, comprising a plurality of rigid members each representative of an atomic unit of generally spherical shape each of which rigid members carries at least one element of a two-element snap fastener of the head-and-socket type rigidly and permanently secured to said member and adated to interlock with a mating fastener member carried by another like rigid member, and a plurality of rigid members representing plural-valenced atoms, each such rigid member representative of a plural-valenced atomic unit having rigidly and permanently secured thereto a plurality of such fastening elements in spaced relation to permit attachment thereto of a plurality of similar or dissimilar rigid members, whereby there may be formed a molecular model permitting full rotation about single bonds between adjacent rigid members while maintaining said members securely fastened against accidental separation and with surfaces of adjacent rigid members in contact with each other.

3. A model atomic unit adapted to be used, with other generally similar units, in building a three-dimensional model of a molecule, said model atomic unit consisting of a rigid member of generally spherical shape carrying, rigidly and permanently secured to a surface thereof, an element of a two-element snap fastener, of the head-and-socket type, adapted to interlock with a mating fastener member carried by another model atomic unit to hold adjacent surfaces of the model atomic units in contact with each other and to provide a stable yet flexible and readily severable connection therebetween.

4. A model atomic unit adapted to be used, with other generally similar units, in building a three-dimensional model of a molecule, said model atomic unit consisting of a rigid member of generally spherical shape and having at least one substantially plane surface thereon, and a socket element of a two-element snap fastener, of the head-and-socket type, rigidly and permanently secured to said rigid member at a substantially plane surface thereof, said fastener element being adapted to interlock with a mating fastener element carried by another model atomic unit at a substantially plane surface of the latter to provide a stable yet flexible and readily severable connection therebetween with

substantial contact between adjacent model atomic units.

5. In combination, a model atomic unit adapted to be used, with other generally similar units, in building a three-dimensional model of a molecule, said model atomic unit consisting of a rigid member of generally spherical shape and having at least one substantially plane surface thereon, a socket element of a two-element snap fastener, of the head-and-socket type, rigidly and permanently secured to said rigid member at a substantially plane surface thereof, and a connector member having oppositely disposed snap fastener heads either of which heads is adapted to engage and interlock with said socket element and the other of which heads is adapted to engage and interlock with a second socket element carried by a second such model atomic unit whereby a substantial area of contact between adjacent plane surfaces of the model is provided.

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