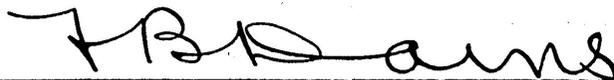


ON THE CONSTITUTION OF CERTAIN PYRAZOLES.

by

Rolla N. Harger.

A thesis submitted to the Department of Chemistry
and the faculty of the Graduate School
in partial fulfillment of the
requirements for the
Master's degree.
1917.



Dep't. of Chem.

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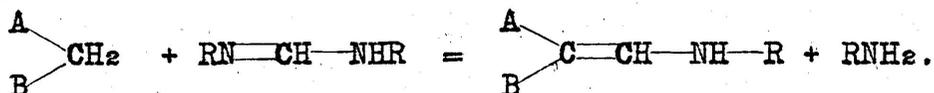
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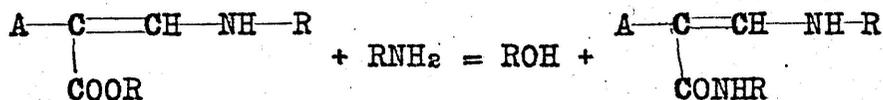
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INTRODUCTION.

While working at the University of Freiburg in 1901-2 Dr. Dains made two important discoveries. First, a new method of synthesizing formamidines by the action of the sesquichloride of HCN upon primary amines (1); and second that when substances containing methylene hydrogen are heated with formamidines the following reaction occurs:



An anilido-methylene compound and a primary amine are thus produced by this reaction. Dains further showed that in case the methylene compound is an ester a secondary reaction takes place as follows:



In the next two years three men presented to the University of Freiburg as theses for their Ph.D. degrees three papers upon "Synthesen mit disubstituierten Formamidinen." The three papers are very similar and for the most part are simply a continuation of the work

(1) Ber. 35:2946.

already laid down by Dains. Each man makes a few new formamidines and using these or others makes some new anilido-methylene compounds. (1) There is, however, one new feature in the work. The action of hydrazine and phenyl hydrazine upon the anilido-methylene compounds is investigated. (2) In this work they investigate (a) the action of phenyl hydrazine upon anilido-methylene acetyl acetone compounds; (b) the action of hydrazine upon anilido-methylene compounds of acetoacetic ethyl ester; and (c) the action of hydrazine upon anilido-methylene acetyl acetone compounds. In all cases a reaction occurs but from their data the investigators

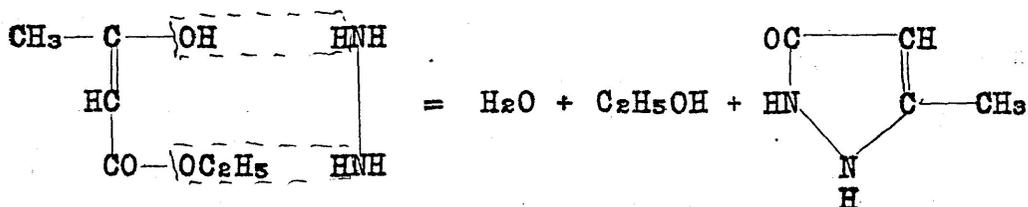
- (1) Karl Gaugler, Dissertation, Freiburg, 1903.
Jakob Gattermann, " " 1904.
Felix Ruggeberg, " " 1904.

So far as we know these papers have never been published in any of the regular chemical journals.

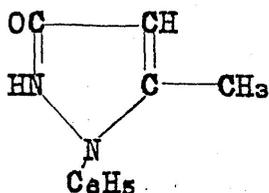
(2) This work was probably suggested by the work of Claisen on the action of hydrazine and phenyl hydrazine upon similar oxy-methylene and ethoxy-methylene compounds of acetyl acetone. Ann. 295:301.

PYRAZOLES OBTAINED FROM ACETOACETIC ETHYL ESTER.

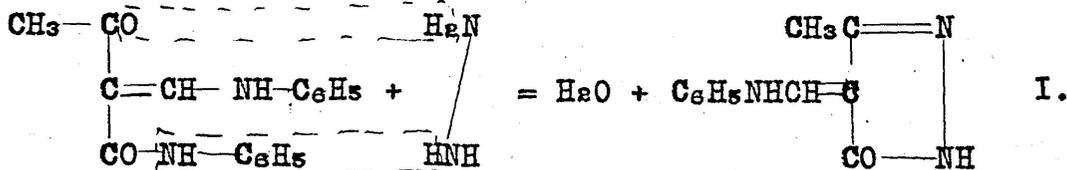
When acetoacetic ethyl ester, or the anilid, is treated with hydrazine the following reaction takes place: (1)



Similarly when phenyl hydrazine is used we obtain 1-phenyl 5-methyl 3-pyrazolon (2):



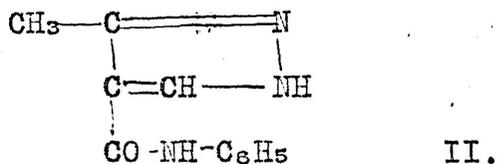
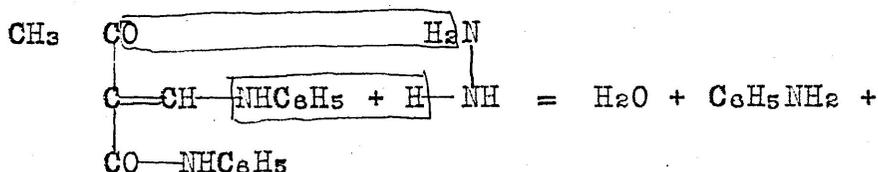
Reasoning from the above reactions it was quite natural for Gaugler and his coworkers to conclude that a substituted anilido-methylene acetoacetic ester would give a pyrazolon when treated with hydrazine. They accordingly write the reaction between anilido-methylene acetoacetanilide and hydrazine as follows:



(1) Curtius and Jay. Pr. Chem. (2) 39:52.
 Knorr, Ber. 25:778.
 (2) Ibid 16:2597.

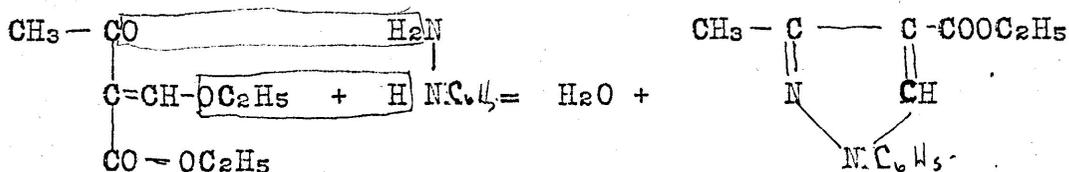
By this action they believe that they obtain 3-methyl
4-anilido-methylene 5-pyrazolon.

There is, however, a second possibility in the
course of this reaction:



Reaction II would produce a pyrazole and not a pyrazolon
although the empirical formulæ of the two compounds
would be the same.

Claisen (1) in his work upon oxy-methylene com-
pounds has shown that when ethoxy-methylene acetoacetic
ester and phenyl hydrazine are allowed to react the
following action takes place:

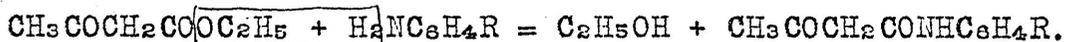


This reaction is exactly analagous to reaction II and
bearing in mind that Claisen's ethoxy-methylene compound

(1) Claisen Ann. 295: 311.

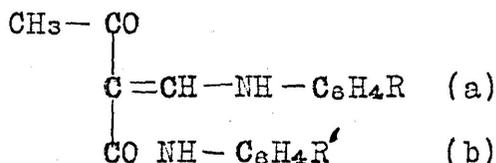
is very closely related to the anilido-methylene compound used here, it is at once apparent that Reaction II is not only possible but extremely probable. We can prove which of the above reactions is the correct one in the following way:

When acetoacetic ethyl ester is heated with aniline or a substituted aniline we get an anilid of acetoacetic acid:



This compound will now react with formamidines (1) like other substances containing acid methylene hydrogen.

In this way we can introduce a substituted anilido group at (a) and a simple or differently substituted anilido group at (b), or vice versa:



Now, when this compound is treated with hydrazine, if equation I is correct $\overset{1}{\text{R}}\text{C}_6\text{H}_4\text{NH}_2$ will split off and our compound will contain the R group. If, on the other hand, equation II is correct our compound will contain group $\overset{1}{\text{R}}$ and $\text{R C}_6\text{H}_4\text{NH}_2$ will be formed. By using this method, Dains and Brown (2) have shown that when phenyl

(1) Dains, Ber. 35:2497.

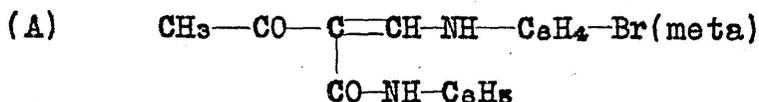
(2) Dains and Brown, J.A.C.S. 31:1156.

hydrazine is used equation II is the right one, since they obtain the same pyrazole by the action of phenyl hydrazine on both anilido-methylene acetoacetanilide and p-toluido-methylene acetoacetanilide.

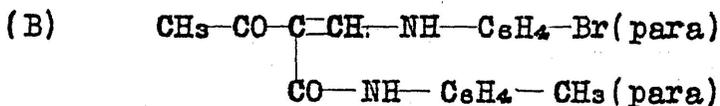
We have now accomplished the same proof in the case of hydrazine upon these anilido-methylene compounds of acetoacetic ester. To make the proof stronger than a C-H-N analysis would give we have used bromine in one of our groups and it was easy to demonstrate the presence or absence of the halogen in our compound.

The following anilido-methylene compounds were made:

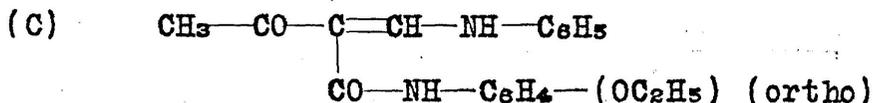
META-BROM-ANILIDO-METHYLENE-ACETOACETANILIDE.



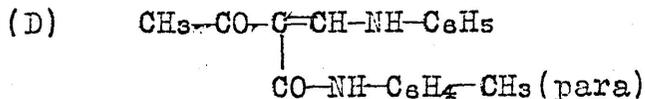
PARA-BROM-ANILIDO-METHYLENE-ACETOACET-PARA-TOLUIDE.



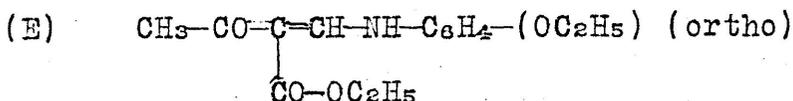
THE ORTHO-ETHOXY-ANILIDE OF ANILIDO-METHYLENE ACETOACETIC ACID.



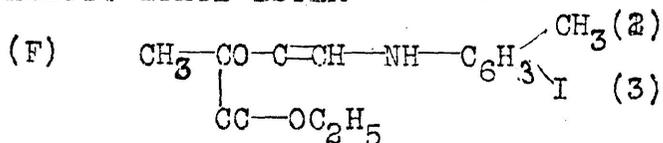
ANILIDO-METHYLENE-ACETOACET-PARA-TOLUIDE



ORTHO-ETHOXY-ANILIDO-METHYLENE-ACETOACETIC-ETHYL ESTER



2-METHYL 3-IODO ANILIDO-METHYLENE ACETO-ACETIC ETHYL ESTER



These were all treated with hydrazine. (A) gave a compound which contained no bromine and which proved to be the same as the compound obtained by Gaugler by the action of hydrazine upon anilido-methylene acetoacetanilide (1). (B) gave a compound which contained no bromine and the analysis of which showed that it is 3-methyl 4-para-toluido-carboxy pyrazole. (C) gave a compound whose analysis agreed with the ortho-ethoxy-anilide of 4-carboxy 3-methyl pyrazole. (D) gave the same compound as (B) and

(1) Gaugler, Dissertation, Freiburg, 1903, p.24.

which proved to be the same as the compound obtained by Gattermann (1) by the action of hydrazine upon the para-toluide of para-toluido-methylene acetoacetic acid. Finally, when compound (E) was treated with hydrazine we obtained a compound whose analysis agreed with 3-methyl 4-carbethoxy pyrazole. When this pyrazole was hydrolyzed with concentrated hydrochloric acid we obtained 3-methyl 4-carboxy pyrazole which was made by Pechmann (2) by the action of diazomethane upon citraconic acid and later treatment with bromine and hydrolysis with hydrochloric acid.

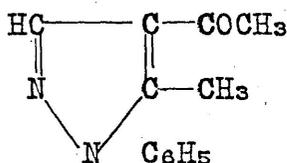
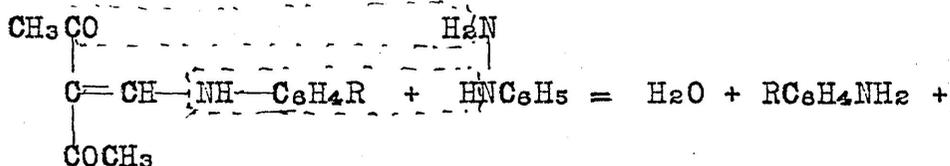
As a further proof that our explanation for the action of hydrazine upon compound (E) is correct compound (F) was treated with hydrazine. We obtained the same compound as was obtained in (E) and also identified the iodo-methyl anilide which split off.

We tried several methods of hydrolyzing the anilido pyrazoles obtained in the above reactions but up to the present time we have not succeeded in doing so. The acid pyrazole obtained from (E) was heated with aniline and also with para-toluidine in the hope of obtaining the pyrazoles which we made from (A) and (B), but this too we were unable to do.

(1) Gattermann, Dissertation, Freiburg, 1904, p.19.
(2) Pechmann and Burchard, Ber. ee 33:3596.

PYRAZOLES OBTAINED BY THE ACTION OF HYDRAZINE AND
 PHENYL HYDRAZINE UPON ANILIDO-METHYLENE ACETYL
 ACETONE COMPOUNDS.

Gaugler and his coworkers seem to have es-
 tablished quite clearly that when anilido-methylene
 acetyl acetone compounds are treated with phenyl
 hydrazine the following reaction takes place:

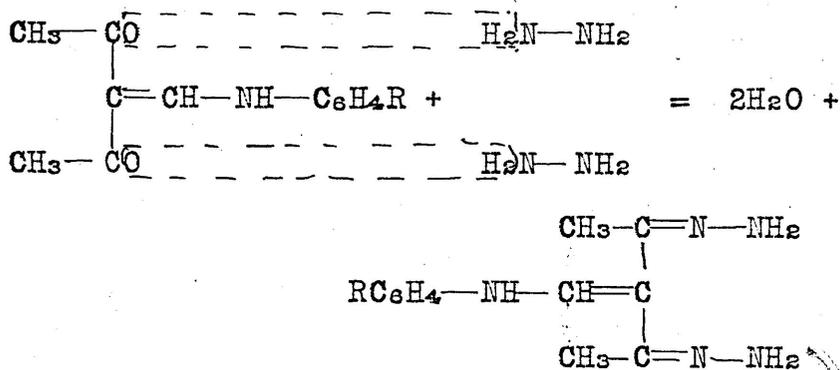


They used several different groups at R and in each
 case they obtained 1-phenyl 4-acetyl 5-methyl pyrazole (1).

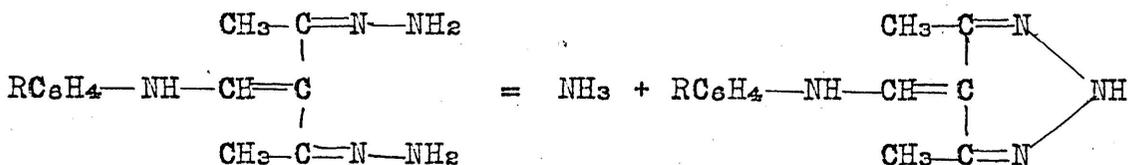
When, however, they used hydrazine instead of
 phenyl hydrazine a compound was obtained whose analysis
 corresponded to $\text{C}_6\text{H}_7\text{N}_3$ and they explained the action
 which had taken place as follows:

-
- (1) Gaugler, Dissertation, Freiburg, 1903, p. 26.
 Gattermann, " " " 1904, p.25.
 " " " 1904, p.27.
 Ruggeburg, " " " 1904, p.30.

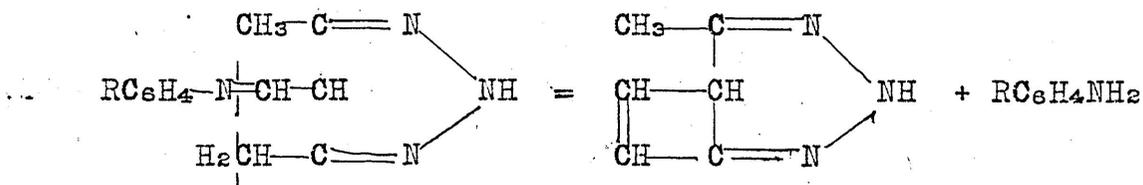
This compound had already been made by Claisen
 (Ann. 295:320) but they seem to have overlooked the fact.



One mole of ammonia now breaks off as follows:

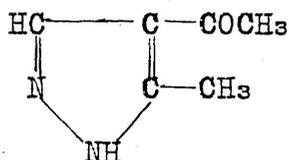
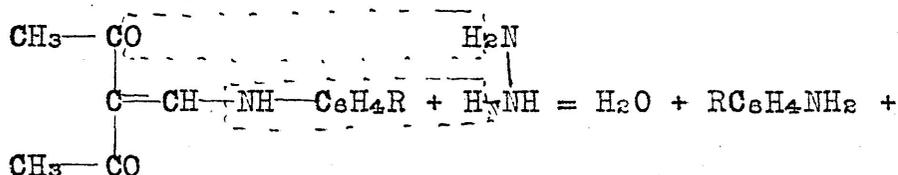


This compound now loses aniline to form a double ring compound, one ring containing four atoms and the other six:

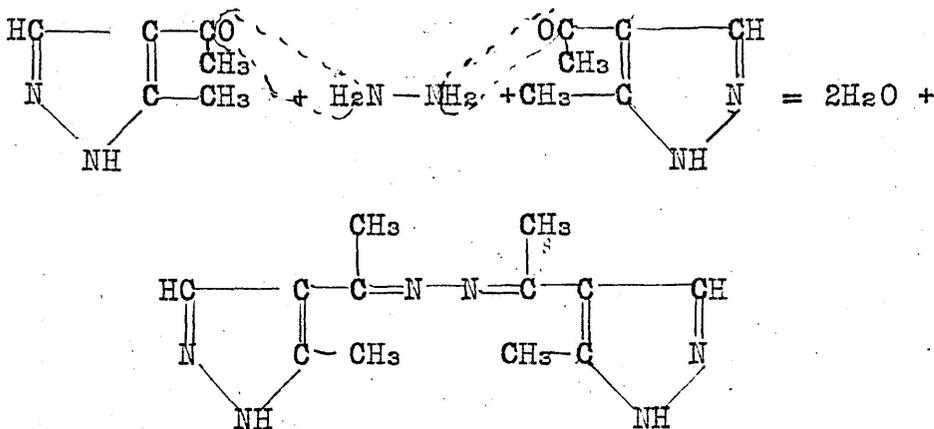


The above course of reaction is improbable; first, because no ammonia gas was detected when we repeated the experiments of these investigators, and second, because the last reaction in which two hydrogens of a methyl group are split off without the use of an oxidizing agent is very unusual indeed.

In considering the above action Dr. Dains observed that a compound corresponding to the above empirical formula could be obtained by the following reactions:

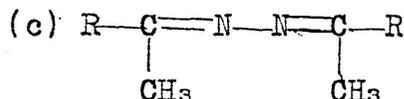
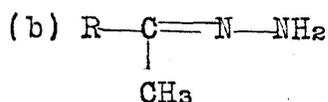
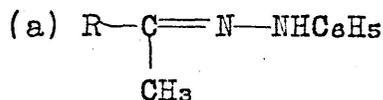


The 4-acetyl 5-methyl pyrazole obtained by this action now reacts with a second mole of hydrazine, two moles of pyrazole condensing with one mole of hydrazine, to give a diazine compound:



This reaction would give $(\text{C}_6\text{H}_8\text{N}_3)_2$ instead of $\text{C}_6\text{H}_7\text{N}_3$ and an analysis would hardly show the difference of one hydrogen. In our work upon this question we have been

able to show that the corresponding 1-phenyl pyrazole, i.e., 1-phenyl 4-acetyl 5-methyl pyrazole, will interact according to the equation proposed by Dr. Dains; and we have isolated the hydrazone (a), phenyl hydrazone (b), and the azine compounds (c):



We also investigated the action of hydrazine upon anilido-methylene acetyl acetone compounds and although we have not yet been able to isolate here the corresponding compounds or even the 4-acetyl 5-methyl pyrazole, we believe that the following points at least strongly indicate that the azine or double compound proposed by Dr. Dains is the correct formula for the product obtained here:

1. In most of their actions, hydrazine and phenyl hydrazine have similar properties.
2. The 1-phenyl compound, as we have shown, follows this course of action.
3. In the case of anilido-methylene acetoacetic

ester or anilid, hydrazine and phenyl hydrazine interact in the same way.

4. Curtius (1) has shown that a great variety of compounds containing the CO group will form such double or azine compounds.

There are, however, two facts which we have observed in this connection which are somewhat at variance with the above arguments. In the first place, the compound which is obtained by the action of hydrazine upon anilido-methylene acetyl acetone compounds melts at a much higher temperature than the double compound which we have obtained from the 1-phenyl pyrazole (320° as compared with 174° for the latter compound). Secondly, when the 174° compound was treated with an acid hydrazine was split off and two moles of the acetyl pyrazole were formed. With the 320° compound, however, we were unable to secure any such action.

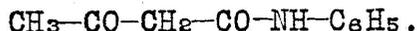
(1) Curtius, Jour. prak. Chem., 39:43.
" " " " 44:161-207.

EXPERIMENTAL PART

-----O-----

I. ANILIDO-METHYLENE ACETOACETIC ACID COMPOUNDS WITH HYDRAZINE.

ACETOACETANILIDE



This was made according to the method of Knorr (1) by heating equimolar quantities of aniline and acetoacetic ethyl ester for three or four hours at a temperature of 120-135°. An oil bath was used to obtain this temperature and the flask was fitted with a long tube to serve as a reflux condenser. This method gives a yield of only about 30 per cent. In order to increase the yield we tried using an excess of aniline and also distilling off the alcohol as fast as it was formed, but neither method gave a much better yield.

FORMAMIDINES.

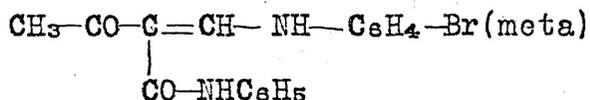
The formamidines used in these experiments were

(1) Knorr, Ann., 236:75.

prepared by heating together two moles of aniline, or a substituted aniline, with one mole of orthoformic ester. The mixture was heated at a temperature of 130-150° for two or three hours. This temperature was usually secured by means of an oil bath but the method of Claisen (1) in which the mixture is heated in a flask fitted with a wide tube about one foot long and a thermometer dipping into the liquid, gave excellent results. In this method the flask was heated by means of an electric hot plate and the alcohol which was formed distilled off from the tube, which was long enough to prevent much orthoformic ester from escaping. The liquid was heated until the thermometer in it registered 160-180°. This temperature indicated that the reaction was complete. The yield of formamidine was almost theoretical and the compound was purified by triturating in a mortar with gasoline filtering and washing with the same liquid. If Claisen's method is used the compound can be obtained in a relatively short time but the temperature must not be allowed to go too high or part of it will be changed into a urea.

(1) Claisen, Ann. 287:366.

META-BROM-ANILIDO-METHYLENE ACETOACETANILIDE.



This compound was made by heating together on an oil bath 18 grams of meta-di-brom di-phenyl formamidine with 10 grams of acetoacetanilide. 10 c.c. of kerosene was used as a solvent. The mixture was heated together on the oil bath for two hours at 140°. At the end of this time it was distilled with steam. The distillate came over cloudy. It was treated with benzoyl chloride and sodium hydroxide solution was added and the mixture was shaken until it no longer had the odor of benzoyl chloride. A white solid resulted. This was recrystallized from alcohol. It gave white crystals which melted at 135-136°. This was higher than is given in the literature for the meta-brom anilid of benzoic acid. So I prepared the meta-brom benzanilide by heating together meta-brom aniline and benzoyl chloride. The product consisted of white crystals which melted at 135-137°. This showed that a reaction had taken place in which meta-brom aniline had split off. The residue which remained in the flask after the steam distillation was recrystallized from hot alcohol. It gave yellowish white crystals which melted at 110-113°.

The compound gave the following analysis (KJELDAHL).

.3528 gram substance required 12.41 c.c. N.1602.HCl.

.3680 gram substance required 13.20 c.c. N.1602 HCl.

	Calculated for	Found
	$C_{17}H_{15}O_2N_2Br$	
Nitrogen	7.84	7.90 8.05

The compound was also analyzed for bromine by dissolving it in liquid ammonia and adding metallic sodium until the blue color lasted for one hour. The excess of sodium was then decomposed by adding ammonium nitrate and the ammonia was allowed to evaporate off by standing over night. In the morning the sodium bromide so formed was dissolved in water and was titrated for bromine by the Volhardt method using Ferric Alum as an indicator. The following results were secured:

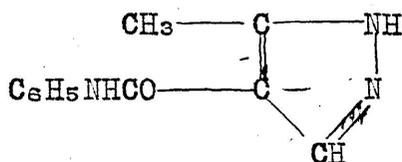
1. c.c. $AgNO_3$ sol. = .00276 g. bromine.

	Theory	Found
Bromine	22.27	22.16 22.84

.1917 gram substance required 15.39 c.c. $AgNO_3$.

.2015 gram substance required 16.68 c.c. $AgNO_3$.

3-METHYL 4-ANILIDO-CARBOXY PYRAZOLE



Placed in a large flask 4 grams of meta-brom anilido-methylene acetoacetanilide and dissolved it in 100 c.c. of alcohol. Dissolved 6 grams of hydrazine sulphate in a small amount of hot water and added to this 5.5 grams of Na_2CO_3 . When the effervescence due to the neutralization had ceased the hydrazine solution was added to the alcohol solution. Fitted the flask with a reflux condenser and heated on the boiling water bath for three hours. In the beginning the alcohol was not sufficient to dissolve the methylene compound even while hot, but after boiling on the water bath it all disappeared and no crystals appeared even upon cooling. The mixture was evaporated to dryness on the steam bath. It was then extracted with methyl alcohol. This methyl alcohol extract was now diluted with water and a little acetic acid was added. Upon shaking a white precipitate appeared. This was recrystallized from hot water. It melted at 179° and crystallized in white rosettes of needles. The compound was tested for bromine but

gave a negative test. Its solubility was as follows:

<u>Solvent</u>	<u>Cold</u>	<u>Hot</u>
Alcohol	Slightly	Some
Benzene	"	Slightly
Acetone	Very	-----
Water	None	Quite
Methyl alc.	Very	-----

The above experiment was repeated using an excess of hydrazine sulphate and sodium carbonate sufficient to give an alkaline reaction. This gave a somewhat better yield. The compound gave the following analysis for nitrogen (COMBUSTION):

Sample	.1813 gm.
Moist gas	36.6 c.c.
Barometer	734 m.m.
Temperature	34°.
Vapor tension	28 m.m.
Percentage N found	20.86

Theory N 20.90% calculated for $C_{11}H_{11}ON_3$.

As a further proof that this compound is a pyrazole, and not a pyrazolon, the 3-methyl 4-meta-brom-anilido-methylene 5-pyrazolon, which might result from this action, would give 14.3% of nitrogen.

ACETOACET-PARA-TOLUIDE



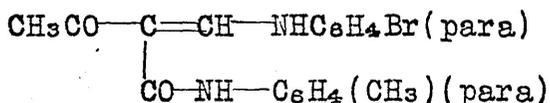
Mixed together in a flask 50 grams of acetoacetic ethyl ester and 26 grams of para-toluidine. The mixture became very cold. The flask was fitted with a long tube which served as a reflux condenser and was heated at 130° on the oil bath for three hours. In about five minutes after starting a vigorous ebullition began and continued for about one hour, after which it boiled more quietly. When the reaction had finished the product in the flask was distilled with steam. During the steam distillation a good deal of oil came over. Upon cooling the product in the flask solidified to a clear yellow mass. This was removed and was recrystallized from hot water. Upon recrystallization from hot water it came down in white flat plates which melted at 89°. The yield here is somewhat better than in the case of acetoacetanilide. The compound gave the following analysis (KJELDAHL):

.3772 gram substance required 12.66 c.c. N.1602 HCl.

.3697 gram substance required 12.52 c.c. N.1602 HCl.

	<u>Calculated for</u>	<u>Found</u>
	$\text{C}_{12}\text{H}_{13}\text{ON}$	
Nitrogen	7.37	7.53 7.60

PARA-BROM-ANILIDO-METHYLENE ACETOACET PARA-TOLUIDINE



This was made by heating on the oil bath 11 grams acetoacet para-toluide and 21 grams of di-para-brom di-phenyl formamidine, using 10 c.c. of kerosene as a solvent. The mixture was heated at 120° for two and one-half hours. When it was cooled most of the mass crystallized. The kerosene was then poured off and the solid was triturated in the mortar with HCl solution. A small amount of water was added and the paste was filtered. The solution was then made alkaline and was treated with benzoyl chloride. A large amount of white crystals was obtained which melted at 200°. This proved that the HCl solution contained para-brom aniline. The solid which remained after filtering off the HCl solution was collected on a Buchner funnel and washed with water. It was then recrystallized from hot alcohol and then from diluted glacial acetic acid. The second recrystallization from the acetic acid was found to be necessary in order to remove traces of the formamidine. Otherwise the compound could not be obtained pure enough for analysis. To effect this second recrystallization the compound was dissolved in glacial acetic acid which was then diluted

with water. This caused the compound to be thrown down in pure form. It gave the following analysis (KJELDAHL):

.3775 gram substance required 12.89 c.c. N.1602 HCl.

.3555 gram substance required 11.84 c.c. N.1602 HCl.

	<u>Calculated For</u>	<u>Found</u>
	$C_{18}H_{17}O_2N_2Br$	
Nitrogen	7.51	7.65 7.48

The compound was also analyzed for bromine by the liquid ammonia method with the following results:

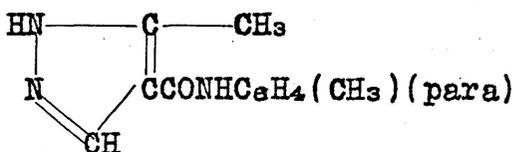
1.0 c.c. $AgNO_3$ = .00276 gram bromine.

.2569 gram substance required 19.90 c.c. $AgNO_3$ sol.

.2565 gram substance required .2005 c.c. $AgNO_3$ sol.

	<u>Theory</u>	<u>Found</u>
Bromine	21.47	21.42 21.57

3-METHYL 4-PARA-TOLUIDO-CARBOXY 5-PYRAZOLE



Put into a 250-c.c. flask 150 c.c. of ethyl alcohol and 7 grams of para-brom-anilido-methylene acetoacet para-toluide. To this mixture were added 2 moles of hydrazine sulphate and an excess of sodium carbonate solution. The mixture was boiled on the water bath

using a long tube as a reflux condenser. At the end of three hours it was placed in an evaporating dish and evaporated to dryness. A sort of paste remained. This was extracted with methyl alcohol as described above and was precipitated by diluting with water and acetic acid. White needles resulted which were recrystallized from hot water. They melted at 179° . This was practically the same melting point as the pyrazole described above, so a melting point was taken of a mixture of the two. This mixture melted at $155-170^{\circ}$. The compound gave a negative test for bromine. Its analysis was as follows:

Sample	.2053 g.	.1985 g.
Moist gas	38.5 c.c.	38.4 c.c.
Barometer	734 m.m.	735 m.m.
Temperature	31° .	32° .
Vapor tension	24 m.m.	26 m.m.
Percentage N found	19.68	20.20
Percentage N calculated for $C_{12}H_{13}ON_3$	19.64	

This compound is somewhat more soluble in hot water than the 3-methyl 4-anilido-carboxy pyrazole described above. The above analysis shows that it is not a pyrazolon because the 3-methyl para-brom-anilido-methylene 5-pyrazolon, which Gaugler thought he had obtained here, would give 14.3

percent of nitrogen.

THE ORTHO-ETHOXY ANILIDE OF ACETOACETIC ACID.



This compound was made by heating together equimolar quantities of acetoacetic ester and orthophenetidine. The mixture was heated on the oil bath for two and one-half hours at 120-130°. The product thus obtained was distilled with steam until no more oil came over. Upon standing the residue solidified in the flask. It was recrystallized from gasoline and gave white, almost transparent needles.

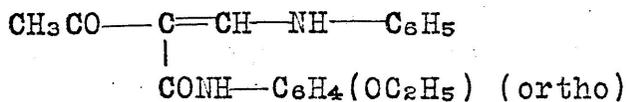
Nitrogen analysis (KJELDAHL):

.3861 gram substance required 11.04 c.c. N.1602 HCl.

.3715 gram substance required 11.53 c.c. N.1602 HCl.

	<u>Calculated For</u>	<u>Found</u>
	$\text{C}_{12}\text{H}_{15}\text{O}_3\text{N}$	
Nitrogen	6.34	6.42 6.85

THE ORTHO-ETHOXY ANILIDE OF ANILIDO METHYLENE ACETO ACETIC ACID.



Mixed together in a flask 5.5 grams of the above anilide with 5.25 grams of di-phenyl formamidine, using 5 c.c. of kerosene as a solvent. Heated on the oil bath for two

and one-half hours at 120-130°. Upon cooling and standing most of the liquid crystallized. Triturated the solid in a mortar with HCl solution and filtered. The solid was recrystallized from alcohol and gave white needles which melted at 135°. Since the melting point of this compound is so near that of di-phenyl formamidine (138°) I feared that the latter compound unchanged might be the product here, but a mixture of this compound with di-phenyl formamidine melted at 115-130°.

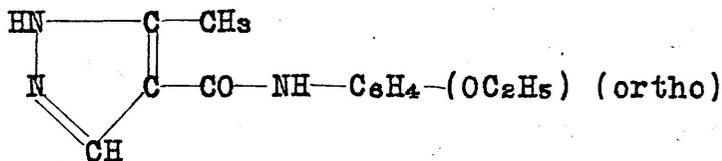
Analysis of the compound (KJELDAHL).

.3228 g. substance required 12.80 c.c. N.1602 HCl.

.3331 g. substance required 13.65 c.c. N.1602 HCl.

	<u>Calculated For</u>	<u>Found</u>
	$C_{19}H_{20}O_2N_2$	
Nitrogen	8.64	8.78 9.07

3-METHYL 4-ORTHO-ETHOXY-ANILIDO-CARBOXY-PYRAZOLE.

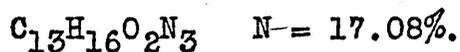


This compound was made in a manner analagous to the other pyrazoles by treating ortho-ethoxy-anilide of anilido-methylene acetoacetic acid with a slight excess of hydrazine sulphate neutralized with sodium carbonate.

It was also made by using hydrazine hydrate (90% alcoholic solution), instead of hydrazine sulphate. Either method gives a much better yield than in the case of the two previous pyrazoles. Upon recrystallization the compound gave white needles which melted at 163° . It has about the same solubility in various solvents as the two pyrazoles already described, except that it is not so soluble in hot water. It gave the following analysis (COMBUSTION).

Sample	.2208 g.	.2591 g.
Moist gas	33.9 c.c.	41.2 c.c.
Temperature	23° .	26° .
Barometer	742 m.m.	731 m.m.
Vapor tension	17 m.m.	19 m.m.
Nitrogen found	16.93%.	17.03%.

Calculated For



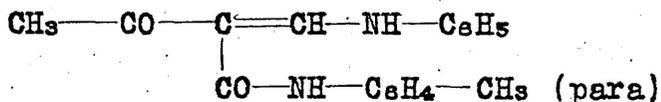
This compound is not a pyrazolon because the 3-methyl 4-anilido-methylene 5-pyrazolon which would be obtained according to Gaugler's equation would have 20.83% N.

THE HYDROCHLORIDE OF THE ORTHO-ETHOXY ANILIDE OF
3-CARBOXY 4-METHYL PYRAZOLE.

Dissolved the above pyrazole in hot benzene and passed in dry hydrogen chloride gas into the boiling solution until no further change took place. A considerable quantity of a white precipitate was obtained which melts with decomposition at 200°. The compound was then analyzed for hydrogen chloride by boiling for some time with an excess of standard NaOH solution and titrating back with standard HCl. It gave the following analysis:

Sample	.3428 g.
Total NaOH solution taken	20.39 c.c.
1 c.c. NaOH = 1.19 c.c. HCl.	
Total HCl taken	16.27 c.c.
Normality of HCl	.1500.
Found percent HCl	12.77
Calculated for $C_{14}H_{15}O_2N_3$, HCl	HCl = 12.96%.

ANILIDO-METHYLENE ACETOACET PARA-TOLUIDE.



This was made by heating together on the oil bath equimolar quantities of acetoacet para-toluide and diphenyl formamidine. A little kerosene was used as a solvent and the mixture was heated for two hours at 120-135°. When it had cooled a sort of pasty mass resulted. This was triturated with HCl solution and the solid filtered off by means of suction. This was then washed and recrystallized from alcohol. It gave white crystals which melted at 162°. It gave the following analysis (KJELDAHL).

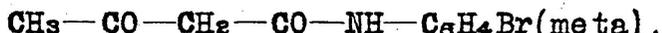
.3319 g. substance required 14.42 c.c. N.1602 HCl.

.3235 g. substance required 13.92 c.c. N.1602 HCl.

	<u>Calculated For</u>	<u>Found</u>
	$\text{C}_{18}\text{H}_{18}\text{O}_2\text{N}_2$	
Nitrogen	9.42	9.60 9.50

This compound was next treated with hydrazine in the usual manner and as a result a compound was obtained which was identical with the 3-methyl 4-para-toluidocarboxy pyrazole. (see page 23).

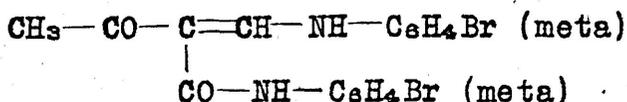
THE META-BROM ANILIDE OF ACETOACETIC ACID.



Six grams of acetoacetic ethyl ester and 8 grams of meta-brom aniline were heated together on an oil bath at 100-110° for five hours. At the end of that time the mixture was distilled with steam and a little oil came over. The residue in the flask was recrystallized from hot water. It gave white plates, soluble in alcohol and hot gasoline which melted at 83°. The compound was analyzed for bromine:

	<u>Calculated For</u>	<u>Found</u>
	$\text{C}_{10}\text{H}_{10}\text{O}_2\text{NBr}$	
Bromine	31.22	31.16 31.17

THE META-BROM ANILIDE OF META-BROM ANILIDO-METHYLENE ACETOACETIC ACID.



Mixed together 15 grams of di-meta-brom di-phenyl formamidine with 5.5 grams acetoacetic ester and 10 c.c. of kerosene. Fitted the flask with a reflux condenser and heated on the oil bath at a temperature of 120-130° for two hours. The mixture was allowed to stand for about a week when a large part of it was found to have crystallized. A part was in the form of a deep

red oil which was insoluble in the kerosene. The oil and kerosene were drained off and the residue washed with alcohol to remove the last of the oil. The residue was then recrystallized from hot alcohol. It gave very light yellow needles which had a melting point of 154° . The compound gave the following analysis for bromine (LIQUID AMMONIA):

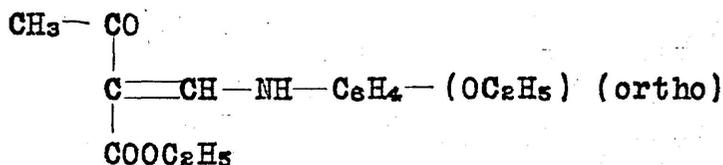
.2140 g. substance required 28.10 c.c. AgNO_3 .

.1859 g. substance required 27.06 c.c. AgNO_3 .

1 c.c. AgNO_3 is equivalent to .00276 g. bromine.

	<u>Calculated For</u>	<u>Found</u>
	$\text{C}_{17}\text{H}_{14}\text{O}_2\text{N}_2\text{Br}_2$	
Bromine	36.51	36.24 36.50

ORTHO-ETHOXY ANILIDO-METHYLENE ACETOACETIC ETHYL ESTER.



This compound was made according to the method of Griffin (1) by heating on the water bath equimolar quantities of acetoacetic ethyl ester and di-ortho phenetetyl formamidine. Quite

(1) Griffin, Master's Thesis, p. 28.

a good yield was obtained.

The above compound was treated with hydrazine hydrate formed by neutralizing hydrazine sulfate with an excess of barium carbonate. Alcohol was used as a solvent. The liquid was boiled on a hot plate for one hour and then evaporated down as far as possible. When it was evaporated to a small bulk drops of oil appeared which were soluble in warm water. These were insoluble in cold gasoline. They were soluble in benzene, alcohol, chloroform and ether. The liquid was recrystallized a number of times from hot gasoline. After long standing the gasoline solution finally deposited crystals, but they were not in a sufficient quantity for analysis or use. The above work was then repeated using larger quantities of the materials and substituting an alcoholic solution of hydrazine hydrate for the hydrazine sulfate. The oil was then crystallized from hotw water. By this method a supersaturated solution was obtained, which upon long standing deposited beautiful colorless needles. The nitrogen analysis (COMBUSTION) was as follows:

Sample	.2688 g.
Moist gas	40.0 c.c.
Temperature	20°.
Barometer	738 m.m.

Vapor tension 11 m.m.

Found nitrogen 16.5 percent.

This nitrogen analysis was too high for the pure compound anticipated here, but it corresponds exactly to a hydrate containing one mole of water ($C_7H_{10}O_2N_2$)H₂O which should contain 16.28 percent of nitrogen. When the 46° compound was allowed to stand in the desiccator over calcium chloride the crystals soon lost their luster and a white powder resulted. After standing in the desiccator for three weeks the substance melted sharply at 54° and gave the following analysis for nitrogen (COMBUSTION).

Sample	.2031 g.	.2073 g.
Moist gas	35 c.c.	34.9 c.c.
Temperature	26°.	23°.
Barometer	726 m.m.	728 m.m.
Vapor tension	15.5 m.m.	13 m.m.
Nitrogen found	18.41.	18.27.
Nitrogen calculated for $C_7H_{10}O_2N_2$		18.18 percent.

This pyrazole was now boiled with concentrated hydrochloric acid for three hours, using a reflux condenser. At the end of that time part of the liquid was evaporated off and upon cooling the remaining liquid deposited colorless crystals which melt with decomposition at 228°. This proves that hydrolysis has taken place to form the acid

described by Pechmann (1) which he obtained by the action of diazo-methane upon citraconic acid and subsequent treatment with bromine and hydrolysis with concentrated hydrochloric acid. Both the pyrazole ester and acid were obtained by Johnson (2) but he did not secure enough of the ester to work with.

2-METHYL 3-IODO ANILIDO-METHYLENE ACETOACETIC
ETHYL ESTER AND HYDRAZINE.

The above methylene compound was heated with an excess of hydrazine hydrate as in the preceding experiment. A reaction took place shown by the fact that 2-methyl 3-iodo aniline could be easily detected. This was done by treating the filtrate with benzoyl chloride and forming the corresponding benzanalide. This melted at 234° and proved to be the same compound as the compound formed by treating 2-methyl 3-iodo aniline, made (3) by Beckley, with benzoyl chloride. The same pyrazole ester was obtained in this experiment as that described in the preceding experiment.

- (1) Pechmann and Burkhard, Ber. 33:3598.
- (2) Johnson, Master's Thesis, 1915, p. 32.
- (3) Beckley, Bachelor's Thesis, 1917.

ATTEMPT AT CONVERTING THE ACID AND ESTER PYRAZOLES INTO THE CORRESPONDING ANILIDO COMPOUNDS.

The 3-methyl 4-carboxy pyrazole described above and the corresponding ethyl ester were each heated with an equivalent quantity of para-toluidine in an attempt to form the corresponding para-toluide. In the case of the acid the heating was carried as high as 210° and with the ester as high as 160° , but in no case were we successful in causing a reaction to take place. The experiments were repeated using aniline instead of para-toluidine, but with the same result.

ATTEMPT TO HYDROLYZE THE ANILIDO-PYRAZOLES.

The anilido pyrazole described above (the anilide of 4-carboxy 3-methyl pyrazole) was heated for some time with strong hydrochloric acid using a reflux condenser. From time to time portions of the liquid were tested for aniline by means of the bleaching powder test but no traces of free aniline could be detected even after several hours heating.

An attempt was next made to hydrolyze the compound using strong sodium hydroxide solution, but we were no more successful here.

Finally, the substance was heated in a sealed tube with 20 percent sulfuric acid at a temperature of 120° .

This temperature was maintained for two hours. When the tube was opened and the contents examined the substance appeared to be decomposed, but no traces of aniline could be detected. In this case we were not able to recover our compound unchanged as was done in the two tests recorded above.

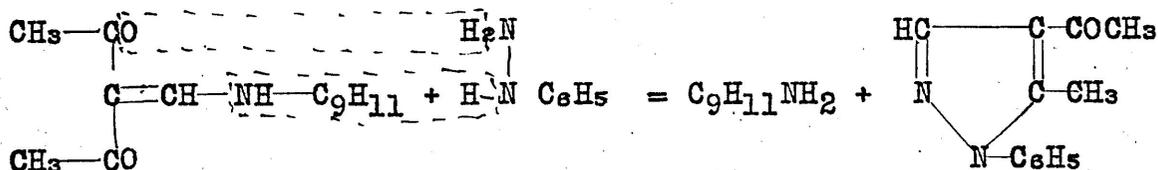
REPITITION OF THE WORK OF GAUGLER AND GATTERMANN.

In making the compounds which we have shown by the above experiments to be anilido-pyrazoles instead of anilido-methylene pyrazolon compounds, Gaugler and Gattermann did not use an excess of hydrazine and sodium carbonate. In order to prove that this modification did not alter the compounds secured we repeated the work of these two men in the action of (1) hydrazine, upon anilido-methylene acetoacetanilide and (2) the action of hydrazine upon the para-toluide of para-toluido anilido-methylene acetoacetic acid. (#) Reaction (1) gave a compound which proved to be identical with the compound described on page and reaction (2) a compound which was identical with the para-toluido pyrazole described on page .

(#) Gaugler, Dissertation, Freiburg, 1903, p.24.
 Gattermann, " " 1904, p.19

II. ANILIDO-METHYLENE ACETYL ACETONE WITH HYDRAZINE AND PHENYL HYDRAZINE.

PSEUDO-CUMIDO-METHYLENE-ACETYL ACETONE + PHENYL HYDRAZINE.



5 grams of the above methylene compound were dissolved in 40 c.c. of alcohol and to this solution was added 5 c.c. of phenyl hydrazine. The flask containing the mixture was fitted with a reflux condenser and heated for 15 minutes on the boiling water bath. At the end of this time the solution was poured into an evaporating dish and evaporated down upon the water bath. A red oil remained. When this was treated with concentrated hydrochloric acid, it solidified and upon adding water and vigorous shaking a pale yellow solid remained. This was partly soluble in hot water and the portion so dissolved when recrystallized from hot water melted at 119-123^o. This proved to be the same compound as the one obtained by Gaugler (1) and his coworkers. The portion which would not dissolve in hot water was found to be soluble in hot alcohol. When recrystallized from this solvent it gave yellow needles

(1) Gaugler, Dissertation, Freiburg, 1903, p.26.

which melted at 175° . Not enough of either compound was obtained to give a good analysis but the melting point of mixtures showed them to be identical with the compounds made from similar anilido-methylene acetyl acetone compounds.

PARA-TOLUIDO METHYLENE ACETYL ACETONE + PHENYL HYDRAZINE.

The above compounds were mixed in molar proportions using a little alcohol as a solvent. Upon standing solution took place with a slight evolution of heat. The flask containing the mixture was then heated for 15 minutes upon the boiling water bath. After cooling the mass crystallized. It was recrystallized from hot alcohol and gave yellow needles which melted at 175° . A mixture of these with the 175° compound obtained from the preceding experiment melted unchanged.

ANILIDO-METHYLENE ACETYL ACETONE + PHENYL HYDRAZINE.

These compounds were heated in molecular proportion as described for similar compounds in the two preceding experiments. Upon cooling and standing, tufts of very small white crystals appeared which when recrystallized from gasoline melted at $125-126^{\circ}$ and proved to be identical with the 125° compound described above. No 175° compound was observed here.

THE PHENYL HYDRAZONE OF 4-ACETYL 1-PHENYL 5-METHYL PYRAZOLE.

40 grams of the orth-ethoxy-anilido-methylene acetyl acetone (1) were placed in a flask and 50 c.c. of phenyl hydrazine (an excess over two moles) were added. The mixture became warm. The flask was now fitted with a long tube to serve as a reflux condenser and was heated on the boiling water bath for one-half hour. Upon cooling the contents of the flask became solid. This solid was dissolved in hot alcohol. Upon cooling it crystallized out in golden yellow needles which when heated at about 170°, turn red and melt at 175-176°. An excellent yield was obtained.

Solubility

<u>Solvent</u>	<u>Cold</u>	<u>Hot</u>
Gasoline	very little	some
Benzene	some	very
Chloroform	very	----
Alcohol	some	very
Acetone	a little	some

The compound gave the following analysis (COMBUSTION).

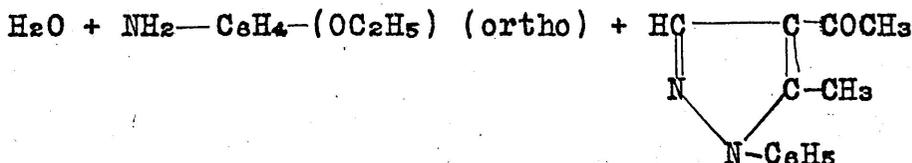
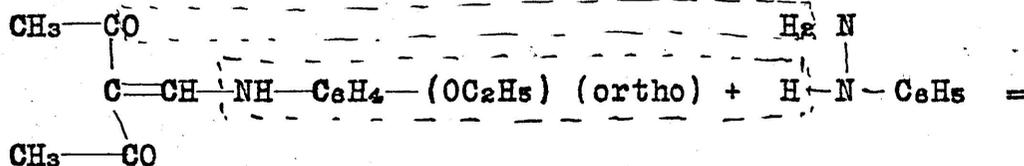
Sample	.2088 g.	.2384 g.
Moist gas	36.4 c.c.	41 c.c.

(1) This compound was made according to the method of Dains and Brown, J.A.C.S. 31:1152. This method gives a very good yield.

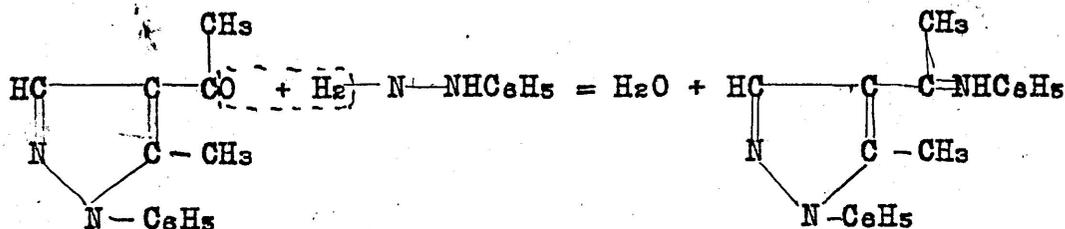
Temperature	22°	22°
Barometer	736 m.m.	732 m.m.
Vapor tension	12 m.m.	12 m.m.
Found nitrogen	19.25%.	18.85%.

Calculated for $C_{18}H_{18}N_4$ N = 19.31%.

This analysis and the experiment in the next section show that the course of the reaction here is as follows:



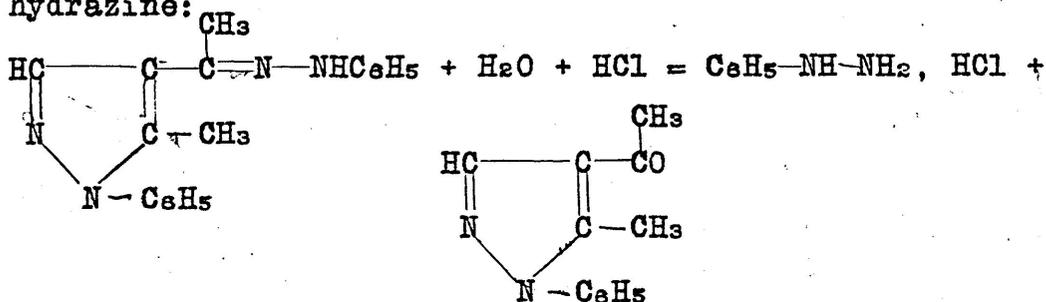
This acetyl pyrazole now interacts with a second mole of phenyl hydrazine to give the corresponding phenyl hydrazone:



THE ACTION OF HYDROCHLORIC ACID ON THE ABOVE PYRAZOLE.

When the above phenyl hydrazone pyrazole was boiled with concentrated hydrochloric acid it easily went into solution. Since the pyrazole itself is insoluble in hot

water it was evident that a chemical change had taken place. Upon diluting the hot solution with water a copious white precipitate came down which increased some upon cooling. When the hydrochloric acid solution is diluted to about four times its volume the precipitate is so copious that the whole mass sets to a sort of white paste. This was now filtered by means of a Buchner funnel and washed with cold water. The precipitate was soluble in hot water, alcohol, hot gasoline and slightly soluble in hot benzene. Upon recrystallization from hot water it gave long silky needles which melted at 102-104°, and which proved to be the same as the compound described on page . A hydrolysis has taken place, the strong hydrochloric acid splitting off one mole of phenyl hydrazine:

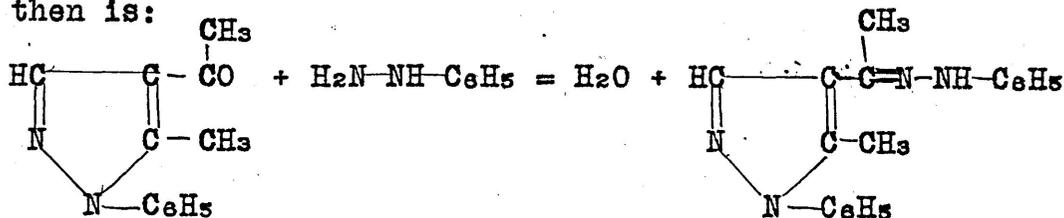


The yield of the 104° compound was very good and as a matter of fact, it was found to be best to go through this process in preparing it for later experiments, since only a small yield resulted when we used one equivalent of phenyl hydrazine.

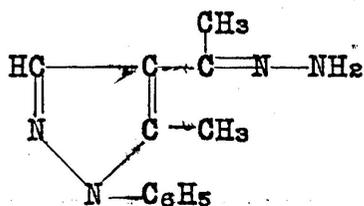
1-PHENYL 4-ACETYL 5-METHYL PYRAZOLE AND
PHENYL HYDRAZINE.

Equivalent quantities of the above compounds were placed in a flask and heated on the boiling water bath for one-half hour. Upon cooling yellow crystals were formed. These were recrystallized from hot alcohol and gave yellow needles which melted at 173-175°. A mixture of these crystals with the 175° compound described in the previous experiment melted unchanged. The reaction here

then is:



THE HYDRAZO COMPOUND OF 1-PHENYL 4-ACETYL 5-METHYL PYRAZOLE.



5 grams of 1-phenyl 4-acetyl 5-methyl pyrazole were dissolved in 50 c.c. of 95% alcohol and to this solution 5 c.c. of 90% hydrazine hydrate were added. The mixture grew quite warm. It was placed in a flask which was fitted with a reflux condenser and heated for one hour on the water bath. At the end of this time the liquid, which smelled strongly of hydrazine, was poured into an evaporating dish and evaporated for two hours on the water bath. At the end of this time an oil resulted which did not have much of the odor of hydrazine. Upon cooling for one day the oil partly solidified and when it was stirred with a glass rod the whole mass suddenly became solid with the evolution of a good deal of heat. This solid was recrystallized from hot gasoline and gave white crystals which melted at 80-100°. An attempt was made to purify it by recrystallizing from various other salts but it seemed impossible to obtain the crystals in a pure form by this method. In order to obtain the crystals of the pure compound the following method was used. 5 grams of the

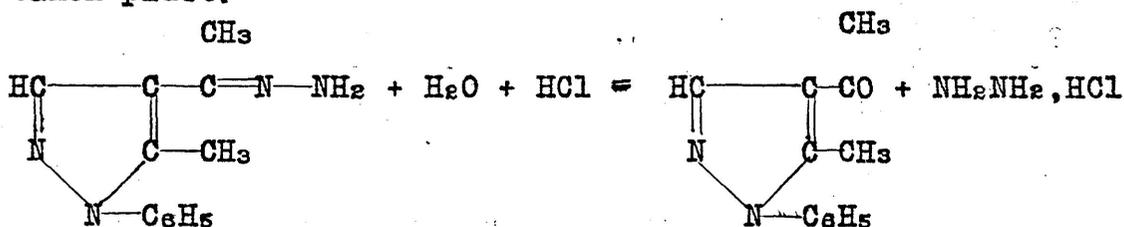
1-phenyl 4-acetyl 5-methyl pyrazole were dissolved in absolute alcohol, and to this were added 5 c.c. of the 90% hydrazine hydrate solution. This mixture was placed in a large test tube fitted with a reflux condenser and was heated on the water bath as before. After half an hour the alcohol was evaporated down to a volume of about 6 c.c. The tube was then stoppered and allowed to stand over night. In the morning long four-sided prisms had separated. The liquid was drained off by suction and the crystals were washed with a little absolute alcohol and dried. They melted sharply at 94-96°. These crystals gave the following analysis (COMBUSTION):

Sample	.1957 g.	.1600 g.
Moist gas	45.6 c.c.	38.5 c.c.
Temperature	24°.	26°.
Barometer	750 m.m.	733 m.m.
Vapor tension	14 m.m.	15 m.m.
Nitrogen found	25.94%.	25.95%.
Nitrogen calculated for $C_{12}H_{14}N_4$	26.17%.	

The compound had the following solubility:

<u>Solvent</u>	<u>Cold</u>	<u>Hot</u>
Alcohol	Very	---
Ethyl acetate	Very	---
Gasoline	Some	Very
Benzene	Slightly	Some

When the compound was boiled with strong hydrochloric acid it at once dissolved and upon diluting with water and cooling a copious white precipitate resulted which was soluble in hot water. It melted at 104° and proved to be identical with 1-phenyl 4-acetyl 5-methyl pyrazole. The following hydrolysis had therefore taken place:



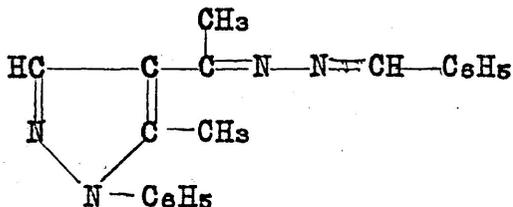
When the above hydrazone compound was dissolved in dry benzene and dry hydrogen chloride gas was passed into the boiling solution a hydrochloride was obtained which melted at 218° with decomposition, and which proved to be the same as the hydrochloride formed from the azine compound described in the next paragraph. The azine compound was probably first formed here by the loss of one mole of hydrazine and then its hydrochloride was formed. In order to prove that the 95° compound described here is really the hydrazone of the pyrazole, we tried the action of benzaldehyde upon it. When a little benzaldehyde was added to the 95° compound heat was evolved and the mixture became yellow. 3 grams of

the 95° compound were dissolved in absolute alcohol and the solution was cooled. An excess of benzaldehyde was then added and the mixture was boiled for some time. Upon cooling yellow crystals were deposited which, when recrystallized from alcohol and then from ethyl acetate, melted at 124-127°. The analysis was as follows (COMBUSTION):

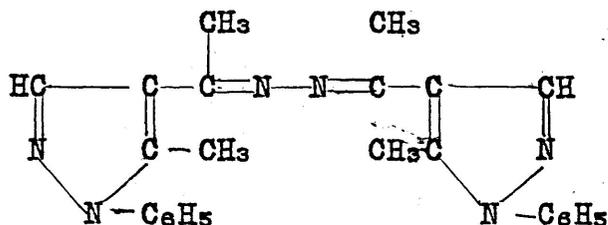
Sample	.2648 g.
Barometer	726 m.m.
Temperature	22°.
Moist gas	44.1 c.c.
Vapor tension	12 m.m.
Found nitrogen	18.04%.

Calculated for $C_{19}H_{18}N_4$ N = 18.54%.

This shows that the following benzal pyrazole azine compound has been formed:



THE DI-AZINE COMPOUND OF 4-ACETYL 1-PHENYL 5-METHYL PYRAZOLE.



When the hydrazone of 4-acetyl 1-phenyl 5-methyl pyrazole described in the above experiment was dissolved in hot ethyl acetate which had been made by students and allowed to stand, yellow crystals separated out which melted at 174°. The ethyl acetate used contained acetic acid and thinking that we might perhaps have here an acetate of the 98° compound we repeated the above using c.p. ethyl acetate. This time no precipitate resulted on cooling and standing but upon adding a little pure formic acid and boiling, the same compound was obtained. It also appeared if the 94° compound was dissolved in 95% alcohol diluted with water and allowed to stand for some days. The carbonic acid from the air probably caused the change here. Five grams of the 94° compound were now dissolved in 100 c.c. of hot ethyl acetate and 3 c.c. glacial acetic acid were added and the mixture was boiled. Upon cooling the 174° compound crystallized out in beautiful yellow crystals which were long and flat. The

compound gave the following analysis (COMBUSTION):

Sample	.1940 g.	.1708 g.
Moist gas	36.2 c.c.	32.3 c.c.
Temperature	14°.	20°.
Barometer	740 m.m.	.740 m.m.
Vapor tension	7 m.m.	11 m.m.
Found nitrogen	21.41%.	21.14%.

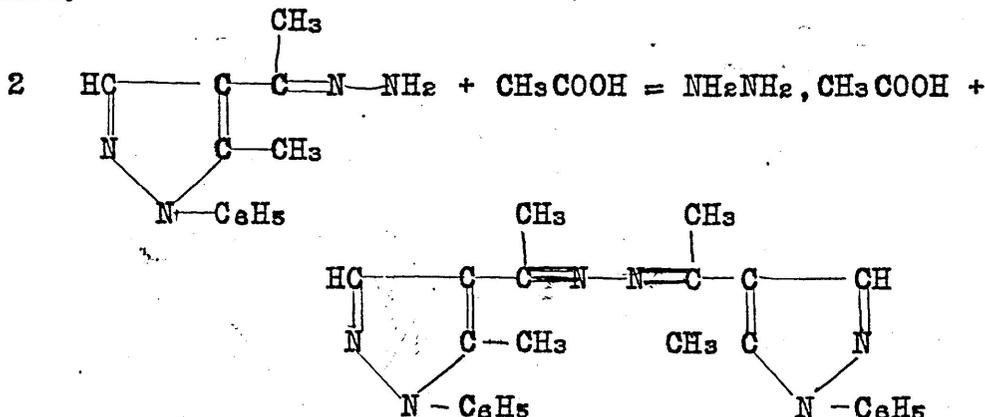
Calculated for $C_{24}H_{24}N_6$ N = 21.65%.

In order to prove that the double compound had been formed here we next took the molar weight of the compound by the boiling point method using chloroform as a solvent

Sample	.7805 gram.
Reading before addition	8.64°.
Reading after addition	8.80°.
Rise in temperature	.16°.
Coefficient for chloroform	36.6.
Molar weight found	388.
Molar weight calculated for $(C_{12}H_{12}N_3)_2$	408.

A Beckmann thermometer was used in this experiment and the heating was done by a coil of wire placed in the liquid using a current of two amperes through the wire.

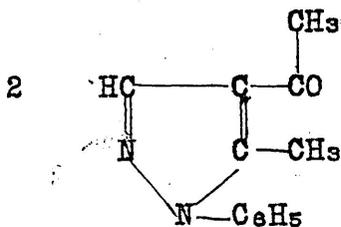
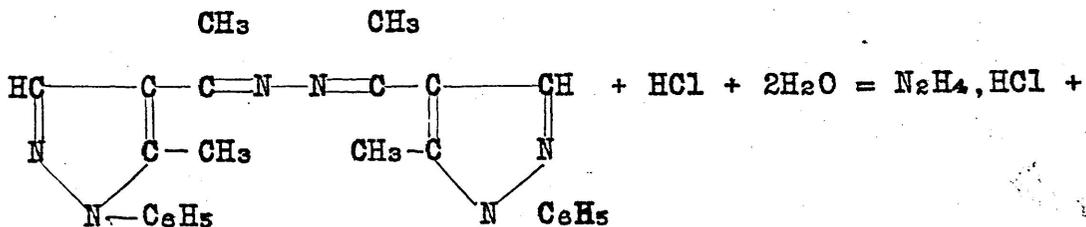
This shows that the following reaction has taken place:



When the above 174° compound was boiled with strong hydrochloric acid it went into solution, and upon cooling and diluting a copious precipitate resulted which was white. This was filtered and washed with water and its solubility and melting point showed it to be the 1-phenyl 5-methyl 4-acetyl pyrazole described above. The filtrate from the above treatment was heated with Fehling's solution and reduced it strongly showing that free hydrazine was present. Neither the 174° diazine compound nor the 104° pyrazole give any reduction when boiled with Fehling's solution. The compound had the following solubility:

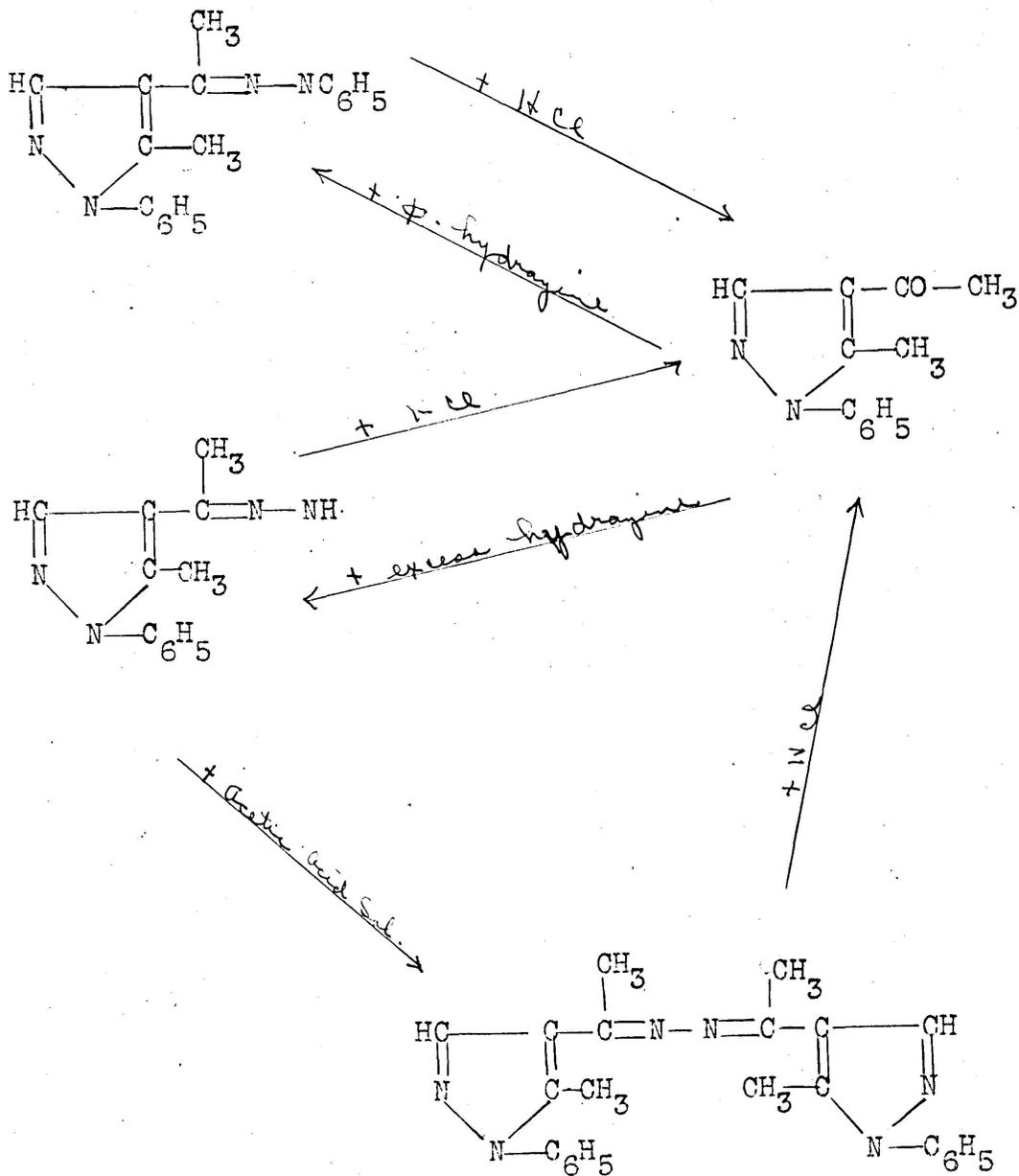
<u>Solvent</u>	<u>Cold</u>	<u>Hot</u>
Ethyl acetate	Some	Very
Alcohol	Very slightly	A little
Water	None	None
Benzene	Sparingly	Some
Chloroform	Some	Very
Glacial acetic acid	Slightly	Some

This shows that the following reaction takes place when this compound is boiled with strong hydrochloric acid:



RELATIONSHIP OF PYRAZOLES.

The following diagram will show the relations which exist between the pyrazoles made from methylene-acetyl acetone.



ORTHO-ETHOXY-METHYLENE ACETYL ACETONE AND HYDRAZINE.

Ten grams of the above methylene compound were dissolved in alcohol. The substance went into solution with cooling. Ten c.c. of 90% hydrazine hydrate solution were then added to this solution. The mixture became very warm. The flask was then fitted with a reflux condenser and heated upon the boiling water bath for two hours. At the end of this time the mixture was cooled but no precipitate appeared even after long standing. Upon evaporating the solution down as far as possible a colorless liquid resulted which would not crystallize upon cooling, but which after long standing deposited a yellow solid which melted at 320° . This compound accorded exactly in physical properties with the compound described by Gaugler which he obtained by the action of hydrazine upon anilido-methylene acetyl acetone (1). We next repeated his experiment carrying it out in exactly the way done by him and obtained this same compound. It is, as he says insoluble in practically all of the organic solvents. It will dissolve slightly in aniline and nitrobenzene. We found, however, that it will readily dissolve in hydrochloric acid, acetic acid or strong sodium hydroxide.

(1) Gaugler, Dissertation, Freiburg, 1903, p.26.

When these solutions are neutralized the same 320° compound was precipitated. This compound was next boiled for some time with hydrochloric acid and the solution was added to Fehling's solution and boiled; but no reduction took place even after the compound had been boiled with strong HCl for six hours. The fact that the addition of hydrazine to the methylene acetyl acetone compound caused a considerable evolution of heat, and that upon heating and evaporating this solution an oil remained which did not deposit the 320° compound for some time, would seem to indicate that an intermediate compound, probably the hydrazone of the 4-acetyl 5-methyl pyrazole was first formed here.

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In conclusion I wish to take this opportunity of expressing my thanks to Doctor Dains, under whose direction this work was carried out, for the helpful advice and encouragement which he was always ready to give whenever it was needed.

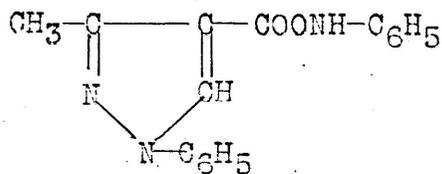
ADDENDAA LIST OF THE PYRAZOLES MADE FROM ANILIDO-METHYLENE
COMPOUNDS WITH HYDRAZINE AND PHENYL HYDRAZINE.

In this list we have given the formula of each pyrazole together with the methylene compound from which it was made, and a reference to the literature describing the experiment.

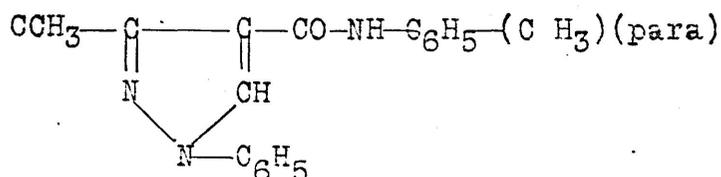
The following abbreviations have been used:

- A. - Gaugler Dissertation, Freiberg, 1903.
- B. - Gattermann Dissertation, Freiberg, 1904.
- C. - Ruggeberg Dissertation, Freiberg, 1904.
- D. - Dains and Brown, J.A.C.S. 31: 1145-1158.
- E. - Johnson, Masters Thesis, 1915.
- F. - This paper.
- #. - Given a wrong constitution.

I. PYRAZOLES FROM PHENYL HYDRAZINE.

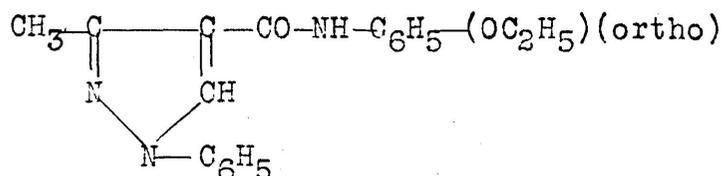


- (1) Anilido-methylene acetoacetanilide - - - - - D. p.1156.
 - (2) Para-toluidido-methylene acetoacetanilide - - - - - D. p.1156.
-

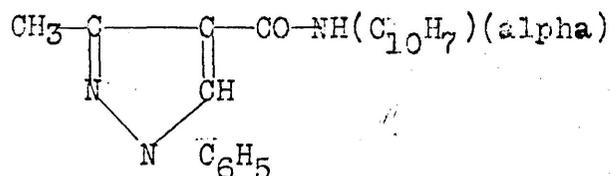


Para-toluidide-methylene acetoacet-para-toluide. - - -C. p.25.

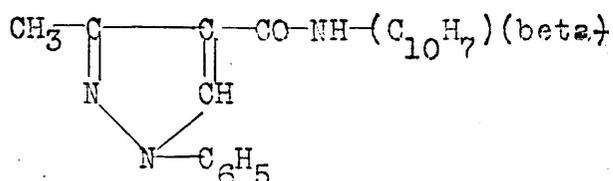
" " " " " " - - - -D. p.1156.



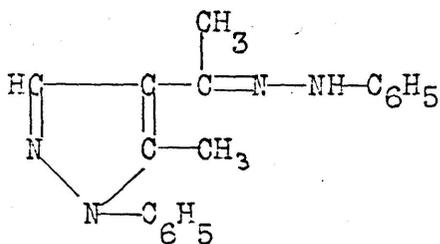
The ortho-ethoxy-anilide of ortho-ethoxy-anilido-methylene acetoacetic acid - - - -E. p.33.



The alpha-naphthalide of alpha-naphthylido-methylene acetoacetic acid - - - -D. p.1157.

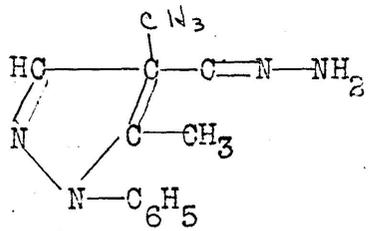


The beta-naphthalide of beta-naphthylido-methylene anilido acetoacetic acid - - - -D. p.1157.

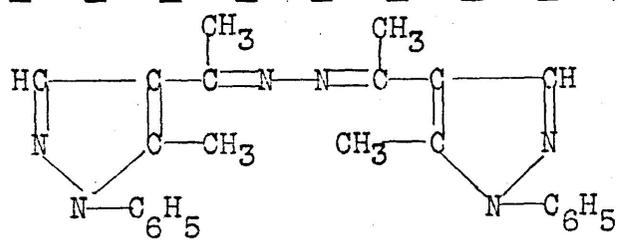


1-phenyl 4-acetyl 5-methyl pyrazole and phenyl hydrazine

F. p.43.



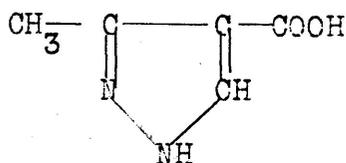
1-phenyl 4-acetyl 5-methyl pyrazole and hydrazine F. p.43.



The above compound when treated with acetic acid in ethyl acetate solution

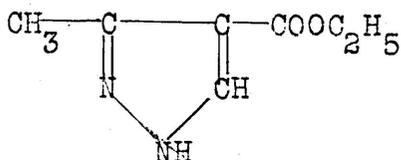
F. p.47.

II. PYRAZOLES FROM HYDRAZINE.



By hydrolyzing the following pyrazole - - - - E. p.32.

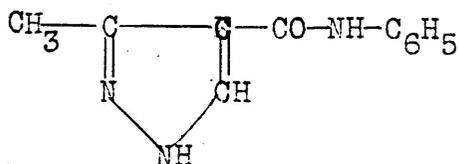
" " " " " F. p.33.



Ortho-ethoxy-anilido-methylene acetoacetic ethyl
ester - - - - E. p.32.

- - - - F. p.31.

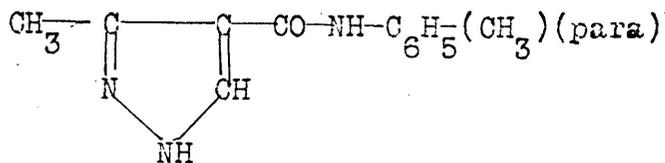
2-methyl 4-iodo anilido-methylene acetoacetic
ethyl ester - - - - -F.-p.34.



Anilido-methylene acetoacetanilide - - - - A. p.24.(#)

Para-toluido-methylene acetoacetanilide - - - - D. p.1156.

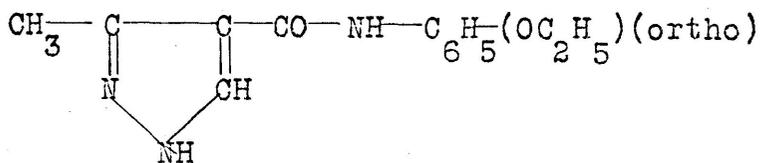
Meta-brom-anilido-methylene acetoacetanilide - - - F. p.19.



The para-toluide of para-toluido-methylene acetoacetic acid - - - - - B. p.19.(#)

The para-toluide of para-brom-anilido-methylene acetoacetic acid - - - - - F. p.23.

The para-toluide of anilido-methylene acetoacetic acid - - - - - F. p.29.



The ortho-ethoxy-anilide of anilido-methylene acetoacetic acid - - - - - F. p.26.